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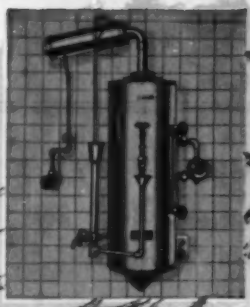

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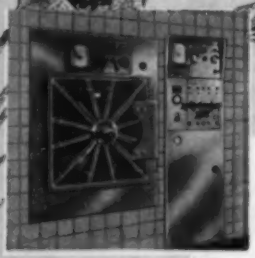

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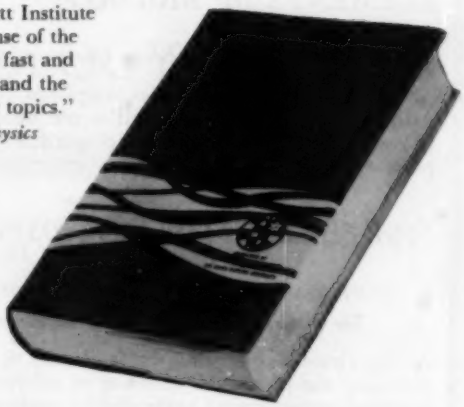

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GROWTH CONTROL OF THE SYMPATHETIC SYSTEM BY A SPECIFIC PROTEIN FACTOR

BY RITA LEVI-MONTALCINI AND PIETRO U. ANGELETTI

Washington University, St. Louis, Missouri

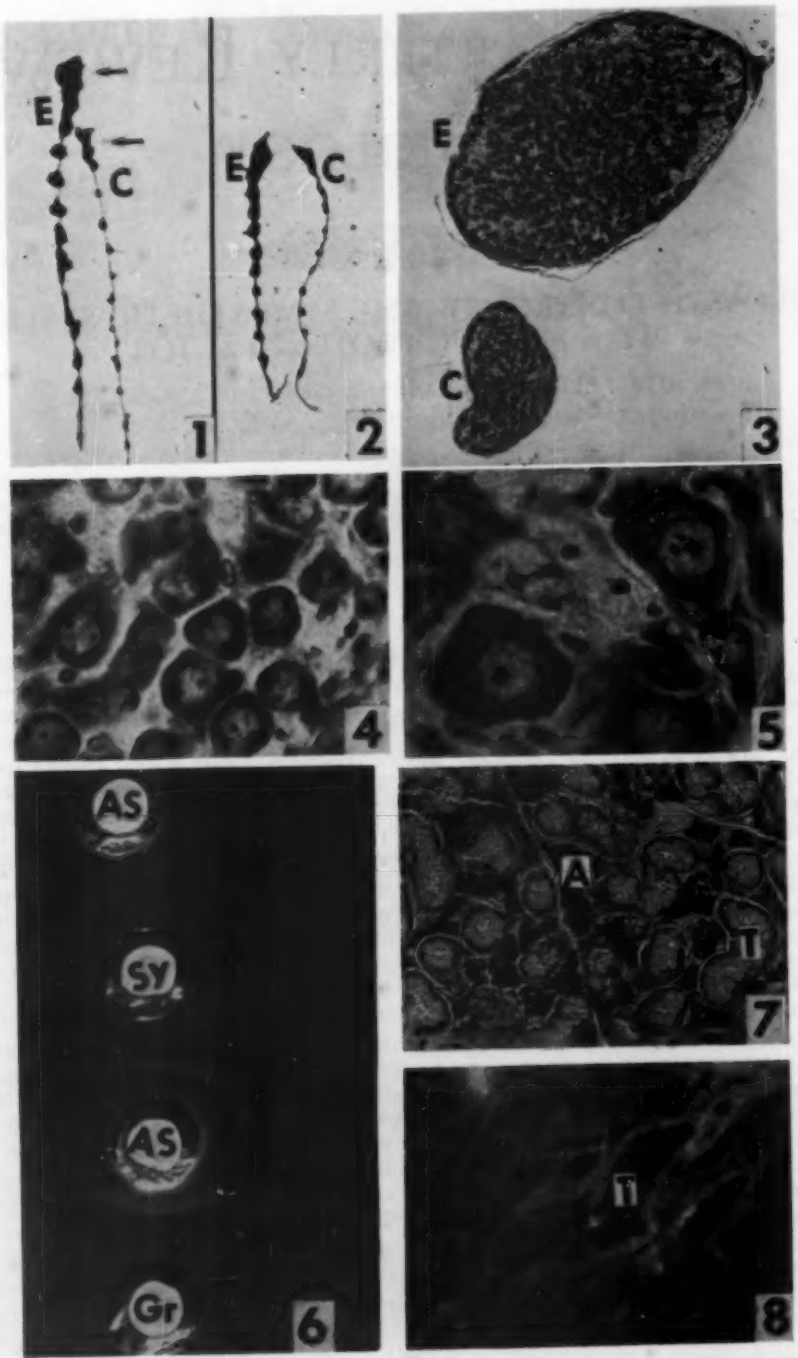
ABSTRACT

The growth, differentiation, and maintenance of the sympathetic nerve cells were found to depend upon a specific protein factor.—The chemical, biological, and immunological properties of this factor are discussed in connection with the recent findings of the presence of the growth factor in the sympathetic nerve cells of a variety of mammals, including man.

INTRODUCTION

IN 1951 a diffusible nerve-growth factor was discovered in mouse tumors of mesenchymal origin (Levi-Montalcini, 1951). It was then found that this factor possesses the striking property of enhancing the growth potentialities of sympathetic and sensory ganglia of the chick embryo, and of producing excessive and abnormal innervation of the embryonic viscera (Levi-Montalcini, 1951, 1952; Levi-Montalcini and Hamburger, 1953). The same ganglia explanted in vitro in the proximity of fragments of these tumors produce an excessive number of nerve fibers within 10 to 16 hours (Levi-Montalcini, Meyer, and Hamburger, 1954). The tissue culture method was then used for assaying at first the whole tumor homogenate and then the different tumor fractions for the nerve-growth activity. This was found to be localized in the microsomes of the neoplastic cells (Cohen, Levi-Montalcini, and Hamburger, 1954). Subsequent investigations by S. Cohen led to the identification of the active agent in a protein or a protein-bound particle (Cohen and Levi-Montalcini, 1957). In the following years two additional sources of a nerve-growth agent were discovered in snake venom and in mouse submaxillary salivary glands (Cohen and Levi-Montalcini, 1956; Levi-Montalcini and Cohen, 1956; Levi-Montalcini, 1958; Cohen, 1958). In both instances the growth factor was identified as a protein particle present in these materials. Experiments in vitro and in vivo showed that the nerve-growth activity of these agents is remarkably similar to the activity of the sarcoma agent. The mouse submaxillary salivary gland, the most readily available and the most potent of the three sources, was used in all subsequent investigations. The injection of the purified salivary gland extract into the yolk of 6- to 10-day-old chick embryos results in a striking enlargement of sensory and sympathetic ganglia and in the hyperinnervation of the viscera and of the exteroceptive sensory areas of the embryos. The injection of the same extract into newborn mice elicits a five-fold increase of the volume of the sympathetic chain ganglia (Figs. 1–3), hyperinnervation of the viscera, and a slight increase of the sensory ganglia (Levi-Montalcini, 1958; Levi-Montalcini and Booker, 1960a; Levi-Montalcini and Cohen, 1960). The injected animals are normal in all other respects. Adult mice respond to the same treatment with a two-fold increase of the sympathetic ganglia (Levi-Montalcini and Cohen, 1960a).

The purified growth agent was found to pos-



FIGS. 1 to 8.

sess strong antigenic properties (Levi-Montalcini and Cohen, 1960; Cohen, 1960). Specific antiserum from rabbit, when injected into newborn mammals, destroys selectively the sympathetic ganglia (Figs. 9–11); the same treatment produces a severe atrophy of these ganglia in adult animals (Levi-Montalcini and Cohen, 1960; Cohen, 1960; Levi-Montalcini and Booker, 1960b). The possibility of producing an overgrowth of, or conversely, destroying selectively, the sympathetic nerve cells in mammals, and the physiological, as well as the physiopathological, implications of this phenomenon, prompted further investigations on the functional significance of the nerve-growth agent. Experiments reported in previous publications (Levi-Montalcini and Booker, 1960a), showed that the nerve-growth factor is detectable in the serum and body fluids of normal mice. It was also found that the same factor can be extracted from granuloma tissue artificially produced in a variety of mammals (Levi-Montalcini and Angeletti, in press). These results indicate that the same or closely related factors with similar biological properties are present in different species. It seemed of particular interest to investigate if the nerve-growth factor is also present in the reacting sympathetic nerve cells. The experiments to be reported in the following pages were aimed at this particular aspect of the problem. The availability of a highly specific antiserum offered a good tool to identify the growth protein wherever present and to ascertain the degree of similarity between the growth factors isolated from different sources.

EXPERIMENTAL PROCEDURES

Tissue extracts

The superior cervical and the stellate ganglia were dissected out from the mouse, rat, cat and cow. In each series of experiments the ganglia were either used individually or were pooled for the preparation of the homogenate. Human sympathetic ganglia were also obtained from autopsy performed within four hours after death. A 10 per cent homogenate in distilled water was prepared from the sympathetic ganglia in a Waring Blendor, and was then centrifuged at 2000 r.p.m. in the Spinco centrifuge for 30 to 40 minutes. The clear supernatant was dialyzed overnight against saline solution and was then used for tissue culture experiments. The protein content was determined by the Lowry method (Lowry, Rosebrogh, Farr, and Randall, 1951), using bovine albumen as a standard. In some instances a partial purification of the crude extract was obtained by streptomycin precipitation and alcohol fractionation. Extraction and purification of the nerve-growth factor from the mouse submaxillary gland was carried out according to the standard procedure indicated by S. Cohen (1960).

Assays in vitro

We used the tissue culture technique as in all previous work (Levi-Montalcini et al., 1954; Cohen et al., 1954). Sensory and sympathetic ganglia from 8- to 9-day-old chick embryos were explanted in a medium consisting of one part of chicken plasma, one part of synthetic medium, and one part of tissue homogenate or one part of saline solution. In some of the experiments, fragments of sympathetic ganglia from mammals were combined with sensory or sympathetic ganglia of chick embryos. In other experiments the ganglia were cultured in the medium containing the tissue homogenate at various dilutions. Readings were made after 6, 12, and 24 hours. The nerve fiber outgrowth was graded from "1" to "4 plus" according to the

FIG. 1. WHOLE MOUNTS OF THE SYMPATHETIC THORACIC CHAIN GANGLIA
E, experimental and C, control mice 19 days old. Experimental mouse injected since birth with the purified salivary gland extract.

FIG. 2. WHOLE MOUNTS OF SAME GANGLIA
E, experimental and C, control mice 12 days old. Experimental mouse injected since birth with the purified salivary gland extract.

FIG. 3. TRANSVERSE SECTIONS OF STELLATE GANGLIA
E, experimental and C, control ganglia shown in Fig. 1. Sections through levels indicated by arrows in Fig. 1.

FIGS. 4, 5. COMPARISON OF CELL SIZE
Fig. 4, control and Fig. 5, experimental stellate ganglia represented in Fig. 3.

FIG. 6. AGAR DIFFUSION REACTION BETWEEN ANTISERUM (AS), SALIVARY GROWTH FACTOR (GR), AND EXTRACT OF MOUSE SYMPATHETIC GANGLIA (SY)

FIG. 7. SECTION THROUGH THE SUBMAXILLARY SALIVARY GLAND OF AN ADULT MALE MOUSE
A, acinar portion; T, tubular portion. Toluidin stain.

FIG. 8. SECTION THROUGH THE SUBMAXILLARY SALIVARY GLAND OF MALE MICE STAINED WITH THE FLUORESCEIN-LABELED ANTIBODIES AGAINST THE PURIFIED SALIVARY GROWTH FACTOR
Note fluorescence in the basilar portion of the tubules (T).

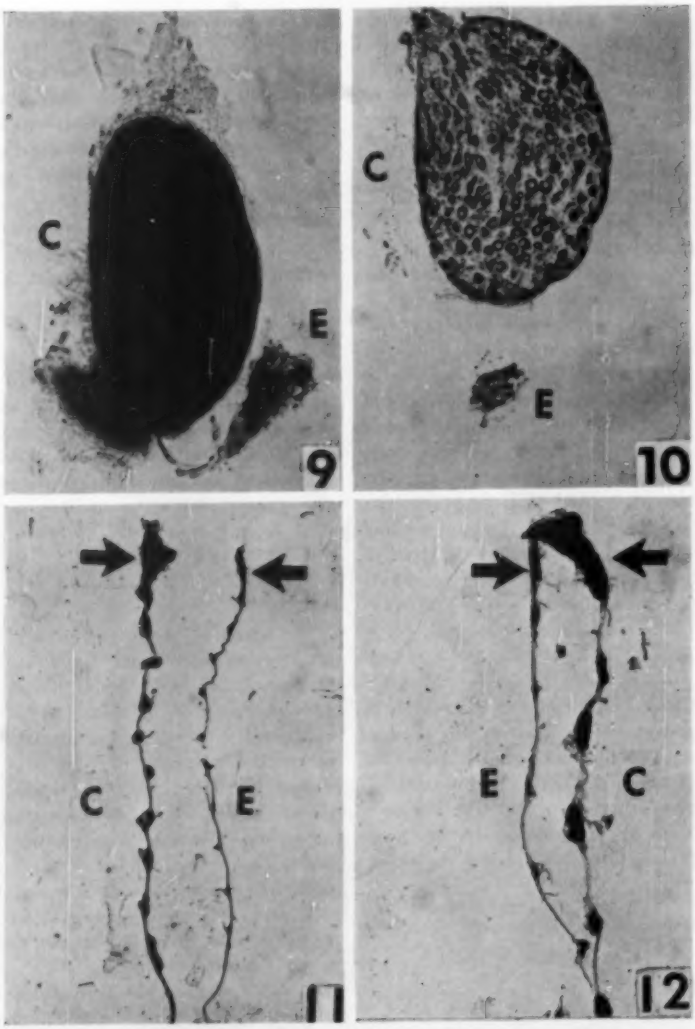


FIG. 9. WHOLE MOUNTS OF SUPERIOR CERVICAL GANGLIA

C, control and E, experimental mice 4 months old. "E", injected from day of birth to the ninth day with the antiserum to the purified salivary gland factor.

FIG. 10. TRANSVERSE SECTIONS THROUGH THE SUPERIOR CERVICAL GANGLIA

C, control and E, experimental 8-month old mice. Experimental mouse injected for three consecutive days after birth with the antiserum to the purified salivary gland factor.

FIG. 11. WHOLE MOUNTS OF SYMPATHETIC THORACIC CHAIN GANGLIA

C, control and E, experimental mice 9 days old. "E", injected since birth with the antiserum to the purified salivary gland factor. Arrows point to the stellate ganglia.

FIG. 12. WHOLE MOUNTS OF SYMPATHETIC THORACIC CHAIN GANGLIA

E, experimental and C, control mice one month old. The experimental mouse was nursed by the mother receiving three injections of the antiserum in the three days following delivery of the litter.

same semi-quantitative criteria used in previous experiments (Cohen, 1958).

Immunological techniques

Immunization of rabbits was obtained by injecting about 1 mg of the highly purified agent (CM3 fraction) emulsified with Freund's adjuvant. Four to five weeks later the animals were bled and the serum assayed by several immunological tests.

Inhibition test of the biological activity

The first assay of the antiserum was based on the inhibition of the biological activity of the nerve-growth factor in tissue culture, as reported by Cohen (1960). 0.2 μg of the purified factor in 0.2 ml of saline were incubated with 0.2 ml of a series of two-fold dilutions of the rabbit antiserum. The mixture was incubated for one hour at room temperature and then diluted to 1 ml with saline solution; aliquots were tested for the inhibition of nerve-growth-promoting activity in tissue culture. The titre of the antiserum is expressed as the reciprocal of the highest dilution which results in complete inactivation of the nerve-growth factor.

Precipitin test

A quantitative precipitin test was performed by adding variable amounts of purified antigen to a fixed amount of serum (Kabat and Mayer, 1958). The protein was measured with the Lowry method (Lowry et al., 1951), using bovine albumen as a standard. In some instances the precipitate was treated for 60 minutes with NaOH 0.1 N, and then tested in tissue culture for the biological activity after being adjusted to pH 7 with 0.1 N HCl.

Complement fixation

Serial two-fold dilutions of antiserum were made and distributed in 0.2 ml amounts: to each dilution series 25 μg of antigen were added in a volume of 0.2 ml and 0.2 ml of guinea pig complement (2 units as determined in the presence of antigen). Dilutions of all the reagents were made in veronal-buffered saline solution. After incubation for 2 hours at room temperature, 0.2 ml of sensitized sheep erythrocytes (1% suspension) were added to each tube, and the test was read after one hour at 37°C. The reciprocal of the highest dilution of the serum still giving a complement fixation represented the titre. The usual controls were included in all tests.

Hemagglutination

A 1:200 tannic acid (Mallinckrodt grade reagent) in saline solution was prepared fresh daily and from this a 1:20,000 dilution of tannic acid was made. Sheep erythrocytes, washed three times and resuspended in saline at 2.5 per cent suspension, were mixed with an equal volume of 1:20,000 tannic acid and incubated 10 minutes at 37°C. The cells were then centrifuged, washed, sedimented again, and finally suspended in buffered saline solution of pH 7.2 to give a final suspension of 2.5 per cent tanned cells. Four volumes of antigen (200 μg/ml) diluted in buffered saline solution were added to one volume of tanned red cells and allowed to stand 15 minutes at 37°C. The sensitized cells were then washed and suspended in 1:100 normal rabbit serum to restore the original volume. The hemagglutination test was performed according to Stavitsky (1954). The titre was expressed as the reciprocal of the highest dilution of the antiserum which gave 4+ hemagglutination. The reactions were graded according to the pattern formed by the agglutinated red cells on the bottom of the tube.

Double diffusion in agar plate

The occurrence of a precipitin reaction between the antiserum and the purified salivary extract and between the crude extract of sympathetic ganglia and the above antiserum was investigated with the Ouchterlony technique as modified by Halbert, Swick, and Sonn (1955).

Fluorescent staining

Antiserum against the purified factor from the mouse salivary gland was prepared according to Cohen (1960). A suitable amount of this antiserum was precipitated with ammonium sulfate and the resulting antibody-gamma globulin fraction was dissolved with veronal-buffered saline solution (pH 7.2) and coupled to fluorescein according to the method of Coons and Kaplan (1950). The non-specific stain was removed by absorption with lyophilized whole liver human homogenate in the proportion of 100 ml of liver powder to 1 ml of stain. Frozen

sections of submaxillary mouse salivary gland and sympathetic mouse ganglia were stained for 1 to 2 hours at room temperature with a few drops of the labelled antibody solution, under a petri dish containing moistened filter paper. The sections were then rinsed in three changes of buffer solution for 10 minutes, mounted in buffered glycerol, and observed with the fluorescent microscope. Control sections were treated first with uncoupled antiserum and then exposed to the coupled antiserum.

RESULTS

Evidence of the growth factor in the sympathetic ganglia

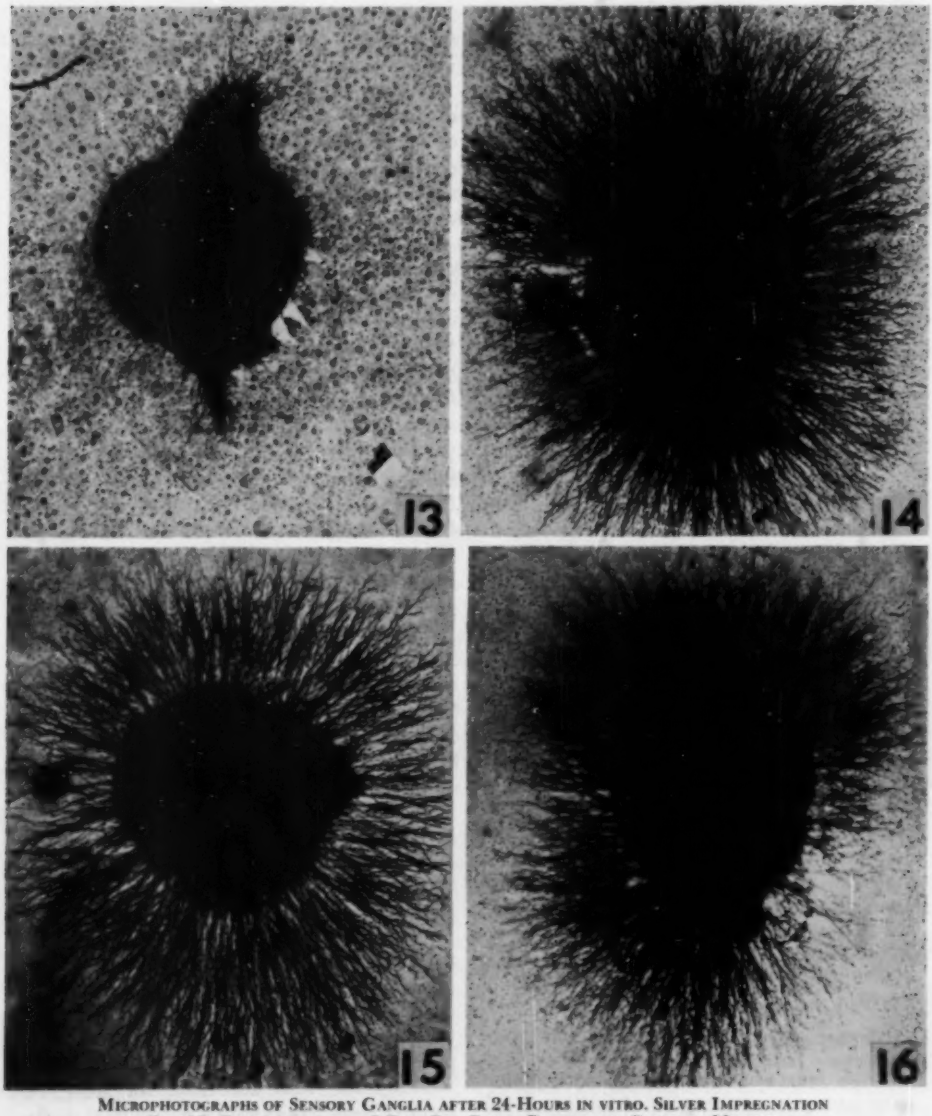
Sympathetic ganglia dissected out from adult mammals (mouse, rat, cat, cow) elicited a nerve-growth effect in chick sympathetic ganglia in vitro. A crude extract of the same ganglia added to the culture medium showed the growth activity. This effect was similar to the one produced by the purified nerve-growth factor. It consisted of the outgrowth of a dense halo of nerve fibers from ganglia of chick embryos by 6 hours after the beginning of the incubation period (Figs. 13, 14, 16). The specific activity as measured by the smallest amount of protein extract required to obtain a 3+ response, was of the order of 200 micrograms per milliliter from mouse and cat ganglia. The specific activity from cat and bovine ganglia was lower. Human sympathetic ganglia obtained from autopsy elicited a similar nerve-growth response (Fig. 15). Table 1 gives the average of the specific activity for each group. The growth factor extracted from the ganglia is nondialyzable, is destroyed by heat treatment, is alkali-resistent (1 hour in 0.1 N NaOH), and is not precipitated by streptomycin. The ultraviolet absorption curve showed a peak of 280 millimicrons. Control experiments with fragments or an extract of nerve tissue of various regions of the central nervous system from different mammalian species gave negative results consistently. The above findings indicate that the nerve-growth factor is present within the sympathetic nerve cells of mammals. Immunological experiments to be reported below gave additional support to this contention.

An extract of mouse, rat, and bovine sympathetic ganglia was incubated with antiserum to the purified growth agent. After 1 hour of incubation, aliquots were tested for biological activity in tissue culture. The results varied from a total to a partial inhibition of the nerve-growth effect, and thus indicated that a cross reaction had taken place.

An extract of mouse sympathetic ganglia was confronted in an agar gel plate with the antiserum to the purified salivary protein, according to the Ouchterlony technique. A single precipitin band formed between the two reactants (Fig. 6).

Immunological properties of the antiserum toward the growth factor

The results reported herein were obtained with pooled antisera from three rabbits bled 5 weeks after the injection of nerve-growth factor in adjuvant. With this stock the inhibition test was positive up to a maximum dilution of 1:1,200. The quantitative precipitin test was used to study the total amount of antigen-antibody precipitated by the antiserum after incubation with varying concentrations of antigen. The precipitin curve, consistent with a single antigen-antibody system, showed a maximum of precipitate in the equivalence zone, followed by a slight decrease in the zone of antigen-excess. Both the precipitates and the supernatants were assayed in tissue culture for their biological activity. None was found in any precipitate. In the supernatant solutions the biological activity was absent in the zone of large antibody excess (Table 2). Since the nerve-growth factor is alkali-resistant, it is possible to recover the biological activity from the precipitate after treatment with 0.1 N NaOH for 60 minutes at room temperature (Cohen, 1960). In our experiments more than half of the original activity of the antigen was recovered in this way from the precipitates in the equivalence zone. In Ouchterlony plates a single band of precipitation was obtained when the antiserum was confronted with the purified nerve-growth factor (Fig. 6). The hemagglutination test was positive up to a maximum dilution of 1:2000 of the antiserum; however, the titre of the antiserum varied by varying the concentration of the growth factor used to sensitize the tanned erythrocytes at a concentration of 200 μg/ml. A good correspondence was



MICROPHOTOGRAPHS OF SENSORY GANGLIA AFTER 24-HOURS IN VITRO. SILVER IMPREGNATION
FIG. 13. GANGLION OF AN 8-DAY-OLD-CHICK EMBRYO IN CONTROL MEDIUM
FIG. 14. GANGLION OF AN 8-DAY-OLD CHICK EMBRYO IN A MEDIUM CONTAINING THE PURIFIED SALIVARY GLAND FACTOR
FIG. 15. GANGLION OF AN 8-DAY-OLD CHICK EMBRYO IN A MEDIUM CONTAINING THE EXTRACT OF A STELLATE SYMPATHETIC HUMAN GANGLION (FROM A 64-YEAR-OLD MAN)
FIG. 16. GANGLION OF AN 8-DAY-OLD CHICK EMBRYO IN A MEDIUM CONTAINING THE EXTRACT OF A COW'S SUPERIOR CERVICAL GANGLION

found in the antiserum titre, as indicated by the hemagglutination and the inhibition tests. Investigation of the reactants by the complement fixation procedure showed that the complement participates in the immunoreaction and is bound to the precipitate. This procedure was found to be the most sensitive in detecting the antibodies; the titre of the antiserum by the

TABLE 1

Specific activity of the nerve-growth factor in extracts of sympathetic ganglia in different mammals

Sympathetic Ganglia	μg Protein Required to Show 3+ Response*
Mouse	180
Rat	230
Cat	400
Cow	320
Man	280

* Each number simply represents an average value from at least three experiments. Because of the limited number of the experiments, the results were considered insufficient for statistical analysis.

TABLE 2

Precipitin reaction between the nerve-growth factor (N.G.F.) and its antiserum

The antiserum was diluted to one-fourth. Both the precipitates and the supernatants were assayed for biological activity in tissue culture.

Antiserum ml	N.G.F. μg	Protein Precipitate mg	Biological Activity	
			Precipitate	Supernatant
0.5	10	0.105	Absent	Absent
0.5	20	0.180	"	"
0.5	30	0.235	"	"
0.5	40	0.290	"	"
0.5	50	0.320	"	"
0.5	60	0.365	"	Trace
0.5	70	0.370	"	Trace
0.5	80	0.320	"	Present
0.5	100	0.345	"	Present
0.5	120	0.310	"	Present

complement fixation test was positive up to 1/54,000.

Cell sensitivity to the antiserum

It has been reported that the injection of the antiserum to the purified salivary factor of mouse salivary glands results in the near-total destruction of the sympathetic ganglia in various mammalian species (Levi-Montalcini and Booker, 1960b) (see Figs. 9–11). Cell counts in the superior cervical ganglia of the treated newborn animals indicate that in most instances only 1 per cent of the nerve cell population was still present at the end of the first month. In the above experiments the newborn animals were injected for a period varying from 1 to 3 weeks: the amount injected daily was 0.05 ml/g of body weight.

It was of interest to establish the sensitivity of the nerve cells by injecting the antiserum for different lengths of time. It was found that two consecutive injections of 0.05 ml/g of body weight in newborn animals are sufficient to produce a maximal effect.

Morphological changes in the sympathetic ganglia are already apparent 12 hours after the first injection. While in control ganglia mitotic activity is very high at birth and continues to the ninth day, in ganglia of injected mice mitotic figures are very rarely observed. Control and experimental ganglia differ in two other respects. In control ganglia, neuroblasts exhibit all different developmental stages from immature to differentiated neurons. On the contrary, in experimental ganglia the cell appears as a uniform undifferentiated population of young neuroblasts. A large number of pycnotic cells are scattered throughout the ganglion. Degenerative processes become more and more severe between the second and the fifth day. Since the dead cells are not replaced, neuroblasts gradually disappear and at the end of the first week the ganglia consist mostly of satellite cells with few scattered neurons. These also are lost in the following weeks, and eventually, at the end of the first month, only 1 to 5 per cent of the nerve cell population is present. This small residual cell population persists during the following months. The surviving cells are much smaller than in control ganglia.

When the antiserum is injected into a pregnant mouse no effect is observed in the litter, an observation proving that the antibodies do not pass across the placenta. The antibodies are instead transferred through the milk, as proved by experiments in which a nursing mouse was injected with antiserum for three consecutive days. In this case a nearly total destruction of the sympathetic ganglia of all newborn mice of the litter was observed (Fig. 12).

Experiments with fluorescent antibodies

Sections of mouse sympathetic ganglia treated with fluorescent antiserum show a mild but consistent fluorescence in the nerve cells' cytoplasm. These experiments, now in progress, are also indicative of the presence of the growth

agent in these nerve cells. No fluorescence is detectable in the satellite cells present in the ganglia.

The same technique was used with frozen sections of mouse submaxillary salivary glands. A bright fluorescence is observed in the tubular portion of the gland, while no fluorescence is detectable in the acinar portion of the same gland (Figs. 7, 8). In both groups of experiments fluorescent staining was abolished by previous incubation of the frozen sections with uncoupled antiserum.

DISCUSSION

The early findings of a nerve-growth factor in mouse sarcomas raised the question of whether the effects elicited by these tumors on sensory and sympathetic nerve cells of the chick embryo were due to some specific growth properties of neoplastic cells (Levi-Montalcini, 1952; Levi-Montalcini and Hamburger, 1954). Subsequent investigations ruled out this hypothesis. It was found that mouse tumors of epithelial origin, when growing in the chick embryo, did not exert any growth effect. The subsequent discovery of potent nerve-growth factors in snake venom and in mouse submaxillary salivary glands showed that this factor is much more widespread than was thought at first, and at the same time suggested these glands as possible sources of the agent. Considerations presented in previous papers did not favor this hypothesis (Levi-Montalcini and Booker, 1960a; Levi-Montalcini and Cohen, 1960). It may suffice to mention here that the growth agent is present in the serum and other body fluids of the mouse even in the absence of salivary glands and that the extirpation of these glands does not affect the growth and development of the sympathetic nerve cells (Levi-Montalcini and Booker, 1960a). These results suggested that the salivary glands may store and dispose of the agent but do not produce it.

The results of the immunological experiments reported now indicate a remarkable degree of homogeneity in the antigenic system. Evidence was in fact obtained of only a single antigen-antibody system when the rabbit antiserum was tested in vitro with the most purified preparations of the growth factor. Since the biological activity of the factor is completely inhibited after precipitation with the specific antibodies and can be restored with alkali treatment of the antigen-antibody complex, it seems reasonable to conclude that the system actually represents the nerve-growth and anti-growth factor complex. However, the possibility cannot be ruled out that this preparation might be contaminated with trace amounts of other antigens and that these contaminants also participate in the immunoreaction. The observation that no growth-promoting activity can be detected in the precipitate indicates that at least one of the antigenic sites of the nerve-growth factor molecule is identical with the biologically active center.

The results of the hemagglutination test coincided to a remarkable extent with the results of the in-vitro inactivation of the nerve-growth factor. The two methods were combined to test the potency of the antiserum.

The recent finding that sympathetic nerve cells of a variety of mammals (mouse, rat, cat, cow, and also man) possess the growth agent presents many points of interest.

It proves that this protein is not species-specific, since it is found in the same cellular type and with a high degree of similarity in different species. Experiments in vitro by S. Cohen (1959) have shown that the growth factor increases the protein synthesis of the reactive nerve cells in vitro. It is conceivable that this agent plays the same role in vivo by activating metabolic processes related to growth, differentiation, and maintenance of the sympathetic nerve cells. The fact that these cells are highly vulnerable to the antiserum to the growth factor shows that this factor is indeed indispensable to the cell.

Results of preliminary experiments with fluorescent antibodies indicate that the same specific protein is present in the sympathetic nerve cells. This finding seems to be of considerable interest in connection with the more general problem of growth and differentiation. It is conceivable that other cellular types might also be under the leading control of specific factors, and that these factors play a key role in developmental processes.

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THE ROLE OF TREHALOSE IN THE ACTIVATION OF DORMANT ASCOSPORES OF NEUROSPORA

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ABSTRACT

Dormant ascospores of Neurospora *remain quiescent and metabolize at a slow rate unless activated by exposure to high temperatures or to chemicals, including certain furans, pyrroles, thiophenes, or organic solvents. As a result of this treatment, a stepwise series of changes is initiated, resulting in a greatly increased respiratory rate, a loss in thermal resistance, and a rise in the respiratory quotient. Up to 30 minutes after dormancy is broken, deactivation by incubation at 4°C is possible, but after this time the process is irreversible. The locus of the metabolic activation has been shown not to reside in the cytochrome system and probably not in terminal oxidation. Moreover, pyruvate carboxylase, as well as the steps leading to oxygen, are probably not directly affected by the activation reaction, although there is evidence for an increase in the amount of cytochrome c available to the respiratory apparatus after activation. A study of the endogenous substrates of ascospores reveals that the carbohydrate fraction that is soluble in 80% ethanol is not utilized until immediately after heat-activation, and its gradual disappearance can be correlated with the respiratory changes which accompany the germination process. This fraction consists mainly of trehalose, which has been identified on the basis of an analysis of crystalline material obtained from dormant ascospores. A hypothesis is proposed suggesting that the activation process in* Neurospora *ascospores consists in the induction of an enzyme system through which trehalose is metabolized, whereas the dormant cell is restricted to a diet of endogenous lipids.*

AFTER a fire in the tropics, it has been observed frequently that a cottony orange growth appears over tree stumps and soil. The mold that arises thus out of the ashes is *Neurospora* which, very likely, owes its success under such unlikely circumstances to a remarkable dormant cell, the ascospore. This cell is formed after meiosis, which occurs within the ascus that, in turn, forms as the result of the fertilization of different mating types. The conidium, or asexual spore, may be one of the elements in the sexual act and is the colored cell to which the organism owes the name, red bread mold.

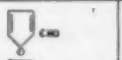
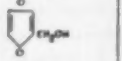
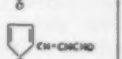
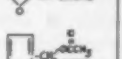
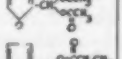
Returning to the ascospore, we find it to be, as Fig. 1 demonstrates, a little black football, about 25 μ in length, with a thick wall consisting of at least three distinct elements. Under ordinary circumstances this cell is dormant, that is, it will not germinate and reinstate the vegetative organism. Ascospores will remain in this subdued, but viable, state for years until they are activated, that is, until dormancy is broken. This may be accomplished by a heat shock, as the data of Goddard (1935) in Fig. 2 reveal. Thus, a 20-minute exposure to temperatures between 50 and 60°C is optimal in eliciting germination.

Another means exists through which dormancy may be broken, that is, by treatment with certain chemicals. As shown in Fig. 3, Emerson (1948) found that furfural and furfuryl alcohol will break dormancy, and work in my laboratory has demonstrated since that time that other furans, in concentrations lower than 1×10^{-3} M, will break dormancy. More recently, aliphatic alcohols, esters, and aldehydes, in very high concentrations, have been shown to function similarly (Sussman, Lowry, and Tyrrell, 1959).

What are the other requirements for germination? In general, ascospores of *Neurospora* are quite self-sufficient, in that germination will occur in water of conductivity grade (Sussman,

FIG. 1. DORMANT ASCOSPORES OF *Neurospora tetrasperma* (Magnification 400 ×)

1954). Consequently, they possess their own energy source and other nutritional requirements necessary for germination. An exception is oxygen which is an absolute requirement, immediately after activation, as the data in Fig. 4 indicate. Thus, when ascospores are incubated anaerobically after being activated, the increase in acetaldehyde production which precedes germination is not observed. Moreover, the fermentative release of carbon dioxide is also altered under these conditions, according to Goddard (1939). Accordingly, the metabolic events which anticipate, and perhaps induce, germination are arrested by anaerobiosis, and

Compound		
Formula	Name	Reference
	Furfural	Emerson 1948
	2-Furfuryl Alcohol	"
	2-Methyl Furan	Sussman
	2 Furfural Acrolein	"
	2 Furfural Diacetate	
	2 Furfural Dipropionate*	

*Active only after 18 hours incubation.

FIG. 3. FURANS WHICH ACTIVATE ASCOSPORES OF *Neurospora*

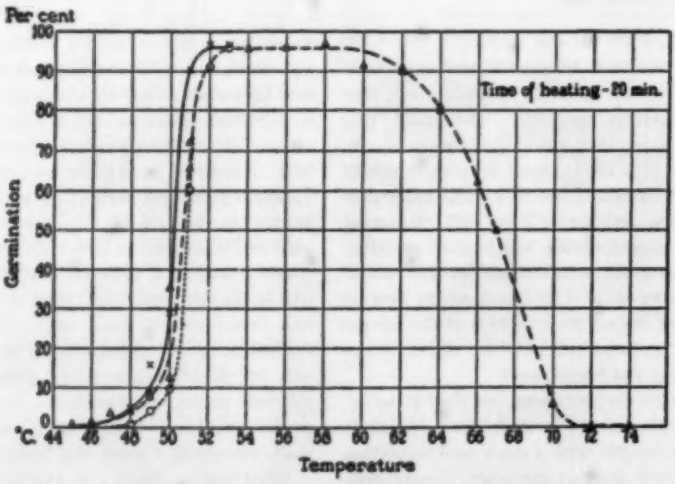


FIG. 2. EFFECT OF TEMPERATURE UPON THE GERMINATION OF ASCOSPORES OF *Neurospora tetrasperma* (Taken from Goddard, 1935)

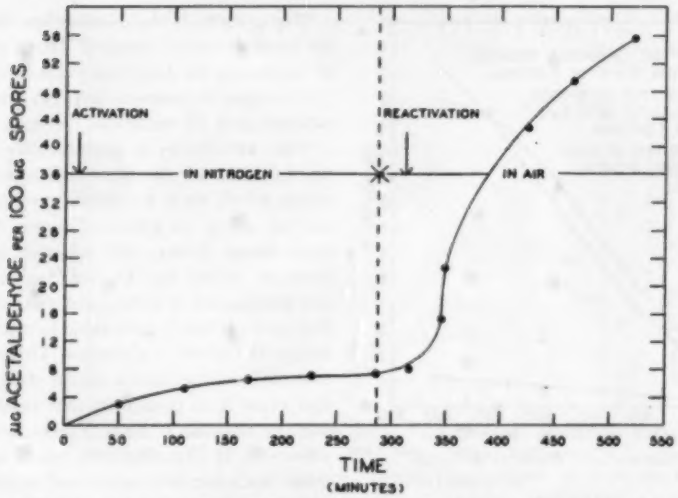


FIG. 4. EFFECT OF ANAEROBIOSIS AND SUBSEQUENT REACTIVATION AND RETURN TO AIR UPON ACETALDEHYDE PRODUCTION BY ASCOSPORES OF *N. tetrasperma*

Activation and reactivation were accomplished by heating at 58°C for 15 minutes, and acetaldehyde analyses were of the suspending medium.

germination does not occur. That this is a reversible arrest has been shown by Goddard (1939) and Sussman et al. (1954), for ascospores that are *deactivated* by anaerobic incubation may be *reactivated* by another heat shock. When reactivation is accomplished, the normal courses of acetaldehyde and carbon dioxide release are reestablished.

The final requirement for germination is a temperature between 6 and 44°C. It is of interest to note that we have shown recently (Sun and Sussman, 1960) that reversible deactivation occurs if spores are maintained at 4°C, an observation suggesting the model illustrated in Fig. 5 for the steps in the activation process. Such a model was first proposed by Goddard (1939), and based upon his pioneering studies with this organism. It should be emphasized that during this time no morphological change can be detected in the ascospore until germination occurs. That there is a stagewise progression of changes during the period of activation can be shown by other means, including decrease in heat resistance and the time when deactivability at 4°C is lost.

One of the strongest evidences in support of this concept deals with changes in the respiratory rate of ascospores as a function of time after activation. The first data of this kind were obtained by Goddard (1935) with heat-activated spores. My own experiments have confirmed and extended the results to include those activated by chemical means, as in Fig. 6. It can be seen that both oxygen uptake and carbon dioxide evolution increase from the time that furfural is added to the suspension of spores. These data are summarized in tabular form in Table 1 and demonstrate the great difference in the respiratory rates of ascospores at different stages of their development.

Accompanying these overall respiratory changes are some in the metabolites which accumulate at each of the stages in germination. These changes are illustrated in Fig. 7. Thus, there is a marked increase in the production of pyruvate, acetaldehyde, and ethanol immediately

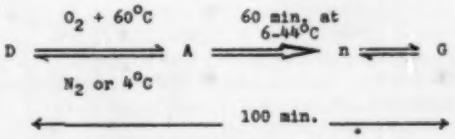


FIG. 5. STAGES IN THE TRANSFORMATION OF DORMANT CELLS OF *Neurospora* TO GERMINATING ONES

D refers to the dormant, A to the activated, and G to the germinating stage.

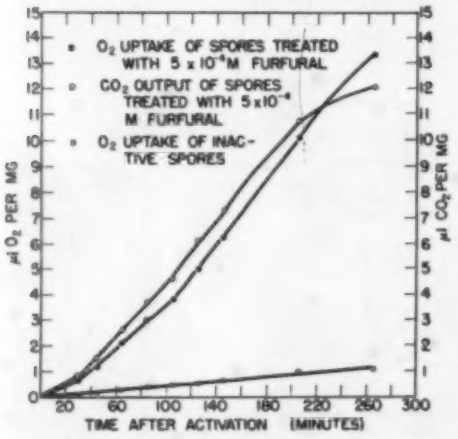

O_2 UPTAKE OF SPORES TREATED WITH 5 x 10^{-4}M FURFURAL
CO_2 OUTPUT OF SPORES TREATED WITH 5x10^{-4} M FURFURAL
O_2 UPTAKE OF INACTIVE SPORES
μl O_2 PER MG
μl CO_2 PER MG
TIME AFTER ACTIVATION (MINUTES)

FIG. 6. RESPIRATORY CHANGES INDUCED BY ACTIVATION OF *Neurospora* ASCOSPORES
(Taken from Sussman, 1953)

upon activation, and the increased rate lasts until just before germination. Moreover, it is not until this time that the complement of Krebs cycle acids becomes complete. Therefore, it is suggested that a fermentative type of metabolism is ushered in by activation, to be replaced by an oxidative one based upon the Krebs cycle.

To summarize the preceding, reference will be made to Table 2. There is a stepwise transformation of an ascospore after activation, from a state characterized by a low R.Q., low Q_{O_2} and great heat resistance, to one that has a higher R.Q., a 20- to 40-fold greater rate of oxygen uptake, and greatly reduced heat resistance. These changes are triggered by a heat shock or chemical treatment, and are reversible at certain stages, as outlined in Fig. 5.

TABLE 1

Respiratory rates of Neurospora ascospores at various stages of development

Stage	Q_{O_2}	R.Q.
Dormant	0.21–0.59*	0.6*
Activated (10 min. to 80 min. after activation)	0.5–20**	0.8–1.2**
Germinating	16.4–24.2*	0.59*

* Data of Holton (1958).
** Data of Sussman (1954).

What, then, is the mechanism that accounts for these dramatic changes? Three general types of explanations have been invoked, including (1) changes in permeability, (2) removal of inhibitors, and (3) metabolic changes.

That alterations in permeability are not primary in this case has been established by experiments which show no significant changes in the rate of influx or efflux of water. Thus, it has been shown (Lowry and Sussman, unpub.) that dormant spores can be dehydrated in glycerol and rehydrated in water, and thereby established that water is freely permeable in either direction, *before the spore is activated*. Throughout these experiments the spores retain their viability so that there is no possibility that exposure to high osmotic tensions is toxic. Furthermore, it is obvious that an organism that needs no exogenous nutrients, other than water and oxygen, assuredly is independent of permeability barriers, at this stage at least. As for accessibility of oxygen, Goddard (1939) has shown that incubation in high concentrations of this gas does not affect the Q_{O_2} of dormant cells, so that it is not likely that permeability to this substance limits metabolism.

As for inhibitors, there is no evidence to suggest their presence even though I have sought them by several means. However, it must be admitted that this possibility still must be borne in mind because permeability barriers exist which prevent a fair test of this hypothesis (Lowry, Sussman, and von Böventer–Heidenhain, 1957; Sussman, Holton, and von Böventer–Heidenhain, 1958).

Our attention has, therefore, been concentrated upon the metabolic hypothesis. Perhaps it is easier to dispose at the start of the systems whose study has revealed no differences before and after activation. These include the following:

(1) Pyruvate-carboxylase, cocarboxylase. Goddard (1939) suggested, as a result of experiments with fluoride, that this enzyme probably was present only after activation. However, a detailed study of this possibility, through isolation of the enzyme and coenzyme (Sussman, Distler, and Krakow, 1956) has conclusively negated this possibility.

(2) Cytochrome oxidase. Several studies have failed to demonstrate enough difference in cytochrome oxidase activity to account

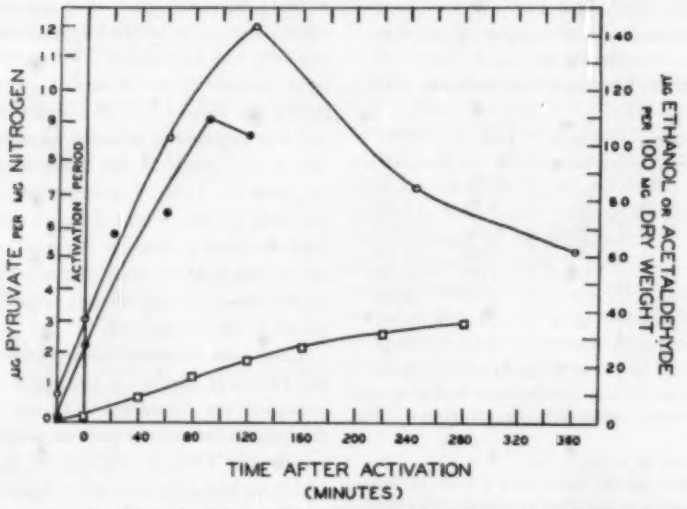

μG PYRUVATE PER MG NITROGEN
ACTIVATION PERIOD
μG ETHANOL OR ACETALDEHYDE PER 100 MG DRY WEIGHT
TIME AFTER ACTIVATION (MINUTES)

FIG. 7. ANALYSIS OF METABOLIC INTERMEDIATES FORMED DURING THE COURSE OF GERMINATION OF *Neurospora tetrasperma*

The pyruvate content in the spore extracts was determined, whereas the ethanol and acetaldehyde analyses were of the suspending medium. Legend: open circles, pyruvate; solid circles, ethanol; squares, acetaldehyde. (Taken from Sussman, Distler, and Krakow, 1956.)

for the changes observed upon activation (Cheng, 1954; Sussman, Distler, and Krakow, 1956; Holton, 1958). However, Holton has shown that cytochrome *c* activity may change dramatically as one of the results—but probably not the cause of activation.

(3) Krebs cycle. The complete complement of acids does not arise until just before germination, so that it is unlikely that these enzymes play a role in activation. However, they are probably involved during the sequential origin of the strongly oxidative type of metabolism that characterizes the germinating cell.

These and other studies led us to conclude that the metabolic block overcome by activation might be anterior to the enzyme systems of terminal oxidation. With this in mind, the substrates that serve as the endogenous fuels of the ascospore were investigated. The amount of lipids at various stages in the development of ascospores was determined (Table 3). Although some lipids are used throughout the time interval studied, their disappearance does not seem to be correlated with the metabolic events which are evoked by activation. Nor do esters, phospholipids, or sterols, when examined as separate fractions, appear to serve in this way. On the other hand, it seems likely that the enhanced utilization of lipids after four hours is associated with

TABLE 2

Summary of the stages between activation and germination and the physiological markers which characterize them in Neurospora tetrasperma

Condition of Spores	Min. after Activation	Physiological Marker: Q_{O_2}*	R.Q.*	Thermal** Resistance	Deactivability at 4°C
Dormant	—	0.5	0.6	+	−
Activated:					
Stage $:					
1	0–20	0.5–4	1.2	+	+
2	30–60	4–10	1.0	−	+
3-n	60–150	15–30	1.0	−	−
Germinating	150	30	0.6	−	−

* Data taken from B. T. Lingappa and Sussman (1959), Goddard (1939), and Holton (1958).

** Data taken from Y. Lingappa and Sussman (1959).

TABLE 3

Lipids of dormant and activated ascospores of Neurospora tetrasperma

(Data from B. T. Lingappa and Sussman, 1959)

Time after Activation	Total Lipids	Total Esters*	Phospho-lipids**	Sterols***
hrs	*mg*		*μmole*	
Dormant	26.6	86.7	5.36	11.24
0	25.5	91.9	6.04	12.23
0.5	24.5	98.7	5.28	12.05
1	25.7	96.7	5.05	10.59
1.5	24.8	102.4	5.12	10.08
2.5	23.9	96.4	6.08	10.08
3.5	25.0	102.1	7.18	9.33
7.5	21.7	96.8	11.97	9.83

All values based upon 100 mg ascospores (dry wt).

* Calculated as tripalmitin.

** Calculated on the basis that 1 mole of inorganic phosphate is equivalent to 1 mole of lecithin.

*** Calculated as ergosterol.

TABLE 4

Carbohydrate fractions of dormant and activated ascospores of Neurospora tetrasperma

(Data from B. T. Lingappa and Sussman, 1959)

Time after Activation	Ethanol-soluble carbohydrates	Acid-soluble carbohydrates	Total carbohydrates
hrs		*mg*	
Dormant	14.0	19.4	33.4
0	12.1	18.6	30.7
0.5	10.4	18.2	28.6
1	8.9	18.1	27.0
1.5	7.4	18.0	25.4
2	6.5	18.1	24.6
2.5	5.6	17.8	23.4
3	4.4	17.8	22.2
4	4.0	17.6	21.6
5	3.3	17.8	21.1
6	2.8	17.6	20.4
8	2.6	17.6	20.2
12	2.1	17.4	19.5
24	1.9	17.5	19.4

All values expressed per 100 mg ascospores (dry wt).

the drop in the R.Q. noted for germinating spores (Table 1).

Accordingly, the sugars of the ascospores were investigated, with the results outlined in Table 4. It is obvious at once that the alcohol-soluble sugar fraction is utilized immediately after activation, *but not before*. This component of the total carbohydrates is stored in amounts approaching 15 per cent of the dry weight of the cell and apparently remains unused during storage of the spores in the dormant condition, as the data in Table 5 demonstrate. By contrast, the data in Fig. 8 and Table 5 reveal that the lipid fraction is used by dormant and activated spores alike. Only after the soluble sugars disappear does a drastic change occur in the rate at which lipids are utilized.

Therefore, it was of importance to determine the chemical nature of the sugar whose disappearance was correlated with the activation of the metabolism of dormant ascospores. The tests outlined in Table 6 were applied to the material, which we had been able to crystallize. From these and other data it was clear that the storage product was mainly trehalose, a non-reducing disac-

TABLE 5

Changes in the endogenous substrates of dormant ascospores of Neurospora tetrasperma

(Data from B. T. Lingappa and Sussman, 1959)

Age of Ascospores	Ethanol-soluble carbohydrates	Acid-soluble carbohydrates	Total Lipids	Germinability
	mg			%
Two-years-old (harvested 1956 and stored at 4°C in air)	13.6	19	21.4	82
One-month-old (harvested 1958 and stored at 4°C in air)	14	19	24	94
One-month-old (stored at 4°C, then shaken 15 days in water at 21°C)	14	19	23.4	93
One-month-old (stored at 4°C, then shaken 40 days in water at 21°C)	14	—	21	96

All values are expressed per 100 mg ascospores (dry weight).

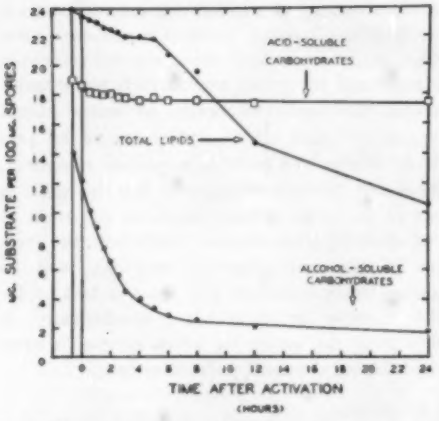
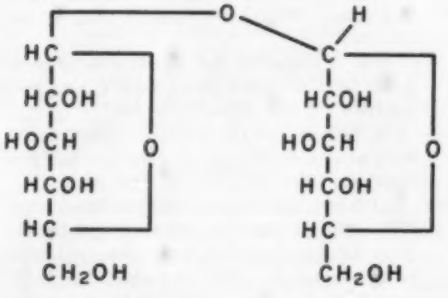


FIG. 8. EFFECT OF ACTIVATION UPON THE AMOUNT OF LIPIDS AND CARBOHYDRATES IN ASCOSPORES OF *Neurospora tetrasperma*

Germination began about 2.5 hours after activation and was complete about 4 hours after. (Taken from B. T. Lingappa and Sussman, 1959).

charide, consisting of two glucose units in α,α-configuration.



α,α-TREHALOSE

Let us now view the role of this sugar from the perspective of the entire life-cycle of *Neurospora*. For instance, can stages other than the activated ascospore utilize trehalose for energy, or is its use restricted to the period immediately following the disruption of dormancy? Part of the answer is supplied by the data in Table 7, which disclose that mycelial, or vegetative, growth is as great in trehalose as on sucrose. In addition, other data reveal that conidia and germinating ascospores respire this sugar as effectively as the other common substrates.

It is reasonable to expect, therefore, that the metabolic block which restrains the development of dormant ascospores is associated with their inability to utilize trehalose; activation might consist in the development of dissimilatory pathways for the utilization of this sugar. Evidence in support of this possibility is offered by the data on the R.Q. in Table 1 which suggest that a sugar is metabolized during the activated stage whereas lipid is the principal fuel used during the dormant and germinating stages. In order to put this surmise to test we have analyzed for trehalase activity and have found it to be present as a constitutive enzyme in the mycelium when the organism is grown on sucrose or maltose. We have not had the opportunity to search for it in ascospores as yet for we have wanted to learn

TABLE 6

Comparison of properties of extract from ascospores of Neurospora tetrasperma and trehalose

(Data from Sussman and B. T. Lingappa, 1959)

Property	Ascospore Extract	Trehalose
Melting point	97°–99° and 205°–210°	96.5°–97.5° and 203°*
Mixed melting point	97°–99° and +176	203°–206° +176
$[\alpha]_D^{20}$		
Rf in butanol acetic acid, and H_2O	0.06	0.06

* Data from Shafizadeh and Wolfrom, 1958.

TABLE 7

Comparison of growth of several strains of Neurospora crassa in trehalose and sucrose

Strain	Days Growth	mg Growth in:	
		Trehalose	Sucrose
"Inos"	4	31.9	30.6
S-4	4	20.2	21.2
T-8	4	29.6	30.1
T-21	4	23.7	22.4
T-24	4	29.8	33.4
T-36	3	34.7	36.6
T-39	3	29.4	28.6
G-1	4	32.2	28.1

more about the enzyme before sacrificing our hard-won stock of spores. It must also be borne in mind that hydrolytic cleavage of trehalose is not the only means by which this sugar can be degraded, for phosphorolytic pathways are known to exist in this organism as well (Leloir and Cabib, 1953).

Many intriguing questions are raised by the involvement of trehalose in the development of *Neurospora*. We have known for years that this sugar is virtually ubiquitous in fungi, but its role has not been understood. It can hardly be coincidence that sclerotia, spores, and similar resistant bodies are the sites of accumulation. Why, then, has trehalose come to serve as a storage product instead of sucrose, for example, which serves in this capacity in other organisms? That this question may have more general relevance is suggested by recent work which has demonstrated that trehalose occurs in many insects (Wyatt and Kalf, 1957) and serves as the precursor of glycogen prior to pupation; moveover, Weinman (1960) has suggested that this sugar is one of the factors which favor the retention of infectivity by trypanosomes. Therefore, the analysis of the metabolism of trehalose, and its control in the organism, may prove to be a profitable exercise in comparative biochemistry, as well as in the means by which control is exercised during dormant periods in fungi.

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THE NUCLEIC ACIDS—METABOLIC KEY TO DEVELOPMENT?

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ABSTRACT

Highly purified preparations of RNA prepared from mature ovarian eggs of Rana catesbeiana contain at least two gross fractions of RNA: one that is soluble in cold 0.5 M perchloric acid (acid-soluble RNA) and another that is insoluble in the same concentration of acid (acid-insoluble RNA). Each comprises roughly 50 per cent of the total RNA. The two RNA fractions are distinct not only in solubility characteristics but in nucleotide composition as well.

A procedure has been developed for the mass isolation of structures morphologically similar to the nucleoli of mature ovarian eggs. These structures contain no DNA, from 8 to 17 per cent RNA, and a large amount of protein.

The distribution of P^{32} in the mononucleotides of cytoplasmic RNA, nuclear RNA, and nucleolar RNA shows that the mononucleotide compositions, based on counts, of nuclear RNA and nucleolar RNA are essentially the same. Nucleolar RNA apparently contains a major component (compound X) which superficially resembles uridylic acid and may be pseudouridylic acid.

That RNA is indeed active in a differentiation process is evidenced by the rapid increase in the rate of incorporation of P^{32} into liver RNA during induced metamorphosis. This response is among the earliest recorded for induced metamorphosis and precedes the increase in activity of many liver enzymes.

INTRODUCTION

IN AN attempt to establish a firm basis for the study of nucleic acid function in amphibian embryonic development, we have examined the chemical nature of the ribose nucleic acids obtained from mature ovarian frog eggs. The theme of our investigations has been the thesis that an accurate assessment of the role of nucleic acids in embryonic development demands the elucidation of the chemical and physical nature of these compounds in the unfertilized egg. As will be shown, the tacit assumption that the characteristics of egg nucleic acid are identical with those exhibited by nucleic acids of somatic cells is misleading and unjustified.

THE RIBOSE NUCLEIC ACIDS OF AMPHIBIAN EGGS

In our investigations of the ribose nucleic acids of amphibian eggs, Volkin and I (Finamore and Volkin, 1961) have found that highly purified ribose nucleic acid (RNA) prepared from mature ovarian eggs of *Rana catesbeiana* is actually composed of at least two gross fractions: one that is soluble in cold 0.5 M perchloric acid (acid-soluble RNA) and another that is insoluble in the same concentration of perchloric acid (acid-insoluble RNA). Each comprises roughly 50 per cent of the total RNA. It must be emphasized at this point that the acid-soluble RNA should not be confused with the so-called acid-soluble free nucleotide pool; the acid-soluble RNA is a fraction of the total RNA itself. Immediately, then, a striking difference is apparent between ovarian egg RNA and the RNA prepared from the liver of the same animal or of a mammal. Whereas approximately 50 per cent of the egg RNA is soluble in acid, virtually no acid-soluble RNA is present in liver RNA prepared in exactly the same manner.

The two ovarian egg RNA fractions are distinct not only in solubility characteristics but

TABLE 1

Nucleotide composition of ovarian egg ribose nucleic acid. Average of six determinations

Acid	Acid-Soluble RNA	Acid-Insoluble RNA
	%	%
Cytidylic	25.3 ± 0.9	29.5 ± 1.7
Adenylic	22.8 ± 1.4	18.8 ± 1.0
Uridylic	21.3 ± 2.2	13.1 ± 2.9
Guanylic	30.5 ± 2.2	38.8 ± 2.7

each exhibits additional properties which distinguish it from the other and from the ribose nucleic acids of differentiated tissue.

The mononucleotide compositions, determined by column chromatography of alkaline digests of acid-soluble and acid-insoluble RNA, are compared in Table 1. It can be observed that the former RNA contains more adenylic and uridylic acids and less cytidylic and guanylic acids than does acid-insoluble RNA. The increase in uridylic acid in acid-soluble RNA over that found in acid-insoluble RNA is equivalent to the decrease in guanylic acid in the acid-soluble RNA as compared with its counterpart. In like manner, the increase in adenylic acid is equivalent to the decrease in cytidylic acid when acid-soluble and acid-insoluble RNA's are compared.

It has been observed also that acid-soluble RNA is not quantitatively hydrolyzed to mononucleotides by alkali. Only about 80 per cent of acid-soluble RNA is recovered as mononucleotides; the remaining 20 per cent, which is apparently resistant to alkaline hydrolysis, can be isolated from the column as a series of seven peaks upon using concave gradient elution.

Acid-insoluble RNA, like acid-soluble RNA, is not quantitatively hydrolyzed to mononucleotides by alkali. Only about 90 per cent of acid-insoluble RNA is recovered as mononucleotides; the remaining 10 per cent can be isolated as a series of six peaks by concave gradient elution.

Several workers have reported the existence of alkali-resistant fractions of RNA from yeast and mammalian tissue (Cohen, 1954; Potter and Dounce, 1956; Lane and Butler, 1959a, b), but this fraction consistently represents only 5 per cent of the total RNA (Lane and Butler, 1959a).

The fact that in the ovarian eggs of *Rana catesbeiana*, 20 per cent of the acid-soluble RNA and 10 per cent of the acid-insoluble RNA are resistant to alkali suggests that a relatively high proportion of alkali-resistant internucleotide linkages may exist in egg ribose nucleic acids, particularly in acid-soluble RNA.

THE NUCLEOLI OF AMPHIBIAN EGGS

Another aspect of our investigations of the ribose nucleic acids of amphibian eggs is the study of nucleolar RNA. We have recently developed a method for the mass isolation of structures morphologically similar to the nucleoli of mature ovarian eggs.

Isolation procedure

Mature ovaries of *Rana pipiens* are excised and washed three times with 0.2 M sodium phosphate buffer (pH 7.4) to remove blood. The tissue is blotted dry and weighed into 10 gram portions, each of which is homogenized in a Ten Broeck type homogenizer in 20 ml of phosphate buffer.

A critical step in the isolation procedure is the preparation of the homogenate. Variation in the percentage of homogenate or in pH drastically affects the yield and purity of the preparations.

The homogenate is centrifuged at 50 × *g* for 14 minutes; the precipitate is discarded and the supernatant fraction recentrifuged at 34,600 × *g* for 45 minutes. This procedure successfully removes yolk platelets and pigment granules. The remaining straw-colored liquid is decanted off through four layers of cheesecloth to remove floating aggregates of fat, and $MgCl_2$ is added to a final concentration of 0.02 M. The nucleoli are then sedimented by centrifugation at 500 × *g* for three minutes. The isolated nucleoli are washed repeatedly with 10 ml of distilled water and sedimented at 500 × *g* until microscopically clean preparations are obtained.

In the development of this method, several series of nucleolar preparations were each washed with 0.025 M sucrose, 0.25 M sucrose, 0.2 M phosphate buffer pH 7.4, or nuclear medium (Rugh, 1948), in addition to distilled water, in an attempt to find a medium which would best maintain the morphological characteristics and individuality of the nucleoli. It was observed that in distilled water the nucleoli did not aggregate; but in all other solutions tested, agglutination, or fragmentation of the nucleoli occurred, or both. Consequently the

morphological, physical, and chemical properties reported here are those exhibited by nucleolar preparations which were washed several times in distilled water.

Determination of nucleotide composition of nucleolar RNA

Twenty mature female *Rana pipiens* were each given daily intraperitoneal injections of 100 μC of P^{32} as orthophosphate. After 48 hours the animals were sacrificed, the ovaries excised, and the nucleoli isolated by the procedure described above. To prevent loss of RNA, the nucleoli were merely dissolved in 0.2 M NaOH and to this solution were added 24 mg of purified frog liver RNA, isolated by the phenol method (Kirby, 1956). The entire mixture was made 0.2 M with respect to NaOH and incubated at 37°C for 15 to 18 hours. Another 24 mg of frog liver RNA were incubated in alkali to serve as the control. After this period of time the samples were adjusted to pH 2 by the addition of HCl, and the precipitate was removed by centrifugation. The mononucleotides were separated by column chromatography using the chloride elution system (Cohn, 1950a, b), and fractions of each peak were pooled and evaporated to a convenient volume. Inorganic phosphorus, which was found to contaminate adenylic and uridylic acids, was removed (Ernster, Zetterstrom, and Lindberg, 1950), and the total radioactivity of each peak was measured using an end-window Geiger tube. In this way the radioactivities of the mononucleotides reflect the contributions from nucleolar RNA, whereas the unlabeled RNA serves as a marker for the ultraviolet identification of mononucleotides during chromatography.

RESULTS

Yield. The dry weight of nucleoli obtained from 10 grams of ovarian tissue ranged from 1.5 to 2.5 mg, and contamination of preparations, as judged by microscopic examination, did not exceed an estimated one per cent.

Physical properties of isolated nucleoli. The nucleoli isolated from mature amphibian eggs are refractile, spherical structures, some of which contain vacuoles (Fig. 1). Their morphological characteristics resemble those of amphibian egg

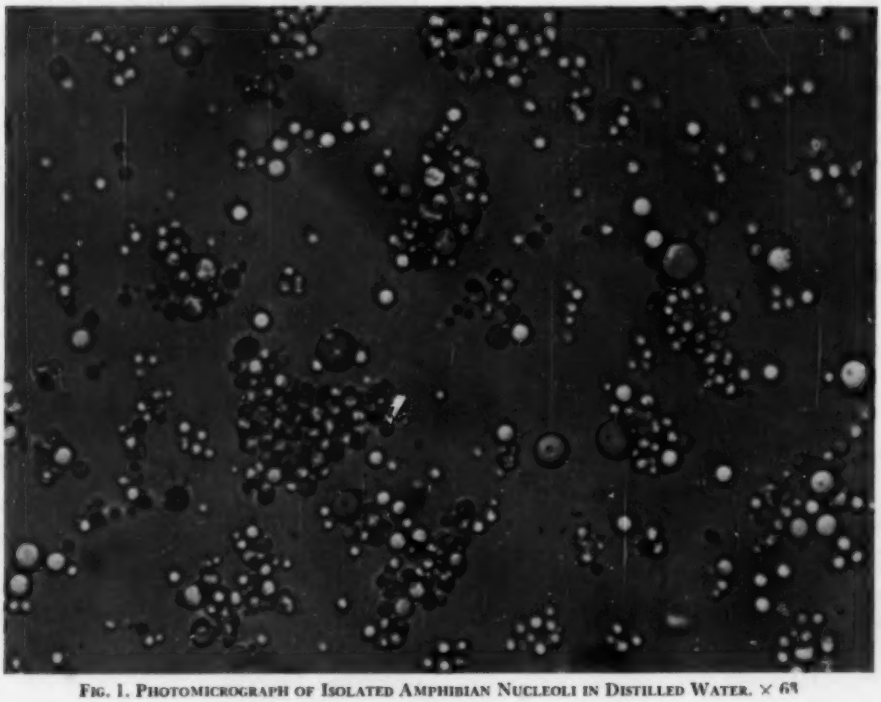

FIG. 1. PHOTOMICROGRAPH OF ISOLATED AMPHIBIAN NUCLEOLI IN DISTILLED WATER. × 63

nucleoli present in intact nuclei. They range from 2 to 16 microns in diameter (average diameter being 6 microns).

The nucleoli are completely dissolved by treatment with 0.1 M NaOH and dilute solutions of trypsin and papain. Weak acids, bases, and salts (0.005 M) have no discernible effect on the nucleoli, but stronger concentrations (0.1 M) of acids and salts cause fragmentation. Varying the pH of the suspending medium from 2 to 9 has little effect on the morphological integrity of these structures, but a 15 per cent increase in average diameter occurs at pH 13. Reversing the pH from 13 to 5 results in fragmentation, as judged by a 12 per cent increase in number of particles in the test samples. The specific gravity of the nucleoli, as measured by gradient sucrose solutions, is between 1.3 and 1.4.

Chemical properties of isolated nucleoli. The diphenylamine reaction (Dische, 1955) failed to show any measurable amounts of deoxyribose nucleic acid (DNA) in 15 nucleolar preparations. The RNA, as measured by orcinol (Mejbaum, 1939), ranged from 8 to 17 per cent of the dry weight of the nucleolus.

Table 2 gives the chemical characteristics of amphibian egg nucleoli, as well as those of nucleoli from other sources. It can be seen that protein is the major constituent of starfish and amphibian egg nucleoli, and the RNA content varies considerably depending upon their source. The lipid content of both amphibian and starfish nucleoli is extremely low.

Nucleotide composition of nucleolar RNA. Fig. 2 shows an elution pattern of, and P^{32} distribution in, an alkaline digest of a mixture of labeled nucleoli and unlabeled purified frog liver RNA added as carrier. It can be seen that the radioactivity follows exactly the ultraviolet-absorbing compounds except for the inorganic phosphate which is recovered between adenosine 3′-phosphate and uridine 2′- and 3′-phosphates. It is apparent, however, that a major ultraviolet-absorbing peak (compound X) is found in this region, and only after careful extraction of inorganic phosphorus could the true radioactivity of this peak be determined. The radioactivity, as represented in Fig. 2, has not been corrected for the presence of the inorganic phosphorus. Compound X has 250/260, 280/260, and 290/260 mμ values similar to but not identical with those of uridylic acid (Volkin and Cohn, 1954), and the slight deviations observed in spectrophotometric ratios may be a reflection of the purity of the compound. Further characterization of compound X and its relation to the pseudo-uridine recently found in other preparations (Cohn, 1957; Davis and Allen, 1957) is currently under investigation.

TABLE 2

Composition of nucleoli from various sources

Compound	Frog	Starfish*	Rat Liver†	Maize‡
	(Percentages)			
RNA	8–17	3–6	2–4	7
DNA	undetectable	undetectable	12–18	—
Protein	74–90	94	—	—
Lipids	small amount	small amount	—	—

* Per cent dry weight. Vincent (1952).
† Per cent dry weight. Dounce (1955).
‡ Histochemical estimation. Dounce (1955).

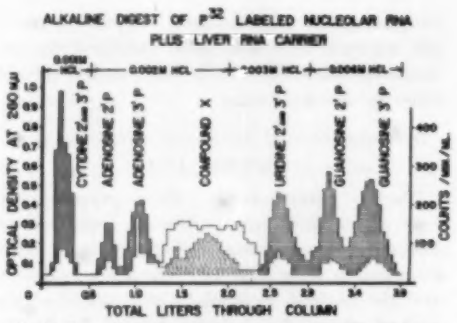

Fig. 2. Elution Pattern of, and P^{32} Distribution in, an Alkaline Digest of a Mixture of Labeled Nucleoli and Unlabeled Frog Liver RNA.

Shaded area represents optical density at 260 mμ and unshaded area represents counts/minute/ml.

The elution pattern of unlabeled frog liver RNA without added nucleoli did not show the presence of compound X, a result which indicates that compound X is an exclusive component of the nucleoli.

The distribution of P^{32} in the mononucleotides of cytoplasmic RNA, nuclear RNA, and nucleolar RNA is shown in Table 3. It should be noticed that the mononucleotide composition, based on counts, of nuclear RNA and nucleolar RNA is essentially the same. The most striking difference between cytoplasmic and nucleolar

TABLE 3

Distribution of P^{32} in mononucleotides and percentage of each mononucleotide in cytoplasmic RNA, nuclear RNA*, and nucleolar RNA*

Nucleotide	Cytoplasmic RNA		Nuclear RNA		Nucleolar RNA	
	Total Counts†	Percentage of Total Counts	Total Counts†	Percentage of Total Counts	Total Counts†	Percentage of Total Counts
Cytidylic acid	50.0	19.3	93.4	11.6	2570	13.2
Adenylic acid	91.0	35.1	195.2	24.2	4480	24.4
Compound X					[6070 + 1530]	40.2
Uridylic acid	32.0	12.3	344.0	42.7		
Guanylic acid	86.6	33.3	174.0	21.5	4240	22.2
Totals	259.6		806.0		18890	

* Data of Finamore and Volkin (1958).

† Counts per minute per total nucleotide.

ribose nucleic acids is the uridylic acid content when compound X is calculated as uridylic acid.

It is of interest that if compound X is omitted from the calculations, the mononucleotide composition, based on counts, of nucleolar RNA and cytoplasmic RNA are equivalent.

The popular notion that nucleolar RNA is the vehicle by which genetic information is passed from the nucleus to the cytoplasm emphasizes the need for characterizing nucleolar RNA with respect to nucleotide composition, metabolic activity, and structure. Of particular interest to us also is the relation between nucleolar RNA and the acid-soluble and acid-insoluble ribose nucleic acid of the whole egg.

So far we have presented evidence that the ribose nucleic acids of amphibian eggs are strikingly different from the ribose nucleic acids of somatic tissues. Now the question arises: Is there jutification for implicating RNA in a differentiation process?

Finamore and Frieden (1960) showed that during induced metamorphosis in *Rana grylio* tadpoles the rate of incorporation of P^{32} as orthophosphate into the RNA of liver is increased and is observable before any morphological transformations are discernible. This response is among the earliest recorded for induced metamorphosis and actually precedes the increase in activity of many liver enzymes. As they point out, it is not unreasonable to assume that the observed response is the prelude to increased enzyme and general protein synthesis.

However, before we can assess accurately the role of the nucleic acids in embryonic development, the chemical and physical characteristics of these compounds must be established in the unfertilized egg. Unless this groundwork is laid important features of the develòpmental process may be overlooked.

ACKNOWLEDGMENT

This work was supported by United States Public Health Service grant RG 5994, and by grant G-4820 from the National Science Foundation.

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will occasionally appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to H. B. Glass, Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

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GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

THE ETHICAL ANIMAL.

By C. H. Waddington. George Allen & Unwin, London. 25s. 230 pp.; ill. 1960.

The restless memories of Auschwitz and Hiroshima, of Bergen-Belsen, Nagasaki, and a thousand other places associated with unimaginable atrocities committed in our midst may never succeed in producing an adequate catharsis. The prospect of annihilation by atomic warfare, though it may sooner than we think overwhelm the just, the misguided, and the guilty, has still to arouse a measure of revulsion minimally commensurate to the situation. Surely, there is a great deal more reason in our time than ever before to ponder the injunctions of ethics, to scrutinize the security of their foundations, to search for compelling directives of individual and societal behavior. The public discussion of these subjects has not been inspired, nor has it reflected a feeling of urgency. Waddington's book is a biologist's contribution to an elucidation of the place which ethical mandates occupy in the scheme of human progress.

The author takes it as an accepted fact that ethical propositions relate to judgments about goodness and feelings of obligation and duty. On this assumption he opens his discussion with a scrutiny of the developmental processes which lead to the formation of the concept "good." "The human infant is born with probably a certain innate capacity to acquire ethical beliefs but without any specific beliefs in particular." During the early months of life the infant turns into what Waddington calls an "ethicizing" being. In due time the individual, as a result of a screening process presided over by his "wisdom," formulates his own specific set of ethical beliefs. These sets of beliefs are established by the passing on and receiving of information and for their becoming effective the child must develop into an "authority acceptor." Thus, in addition to the primary mechanism of transmitting information from one generation to the next by way of the genes, a mechanism shared with all other organisms, man by accepting, and subsequently handing on, directives of behavior has developed a secondary, "sociogenetic," means of evolution. For good or evil he has acquired the power to manipulate or interfere with his own evolution.

In sketching the factors on which biological evolution depends (mutation, developmental processes, organism and environment interrelations, natural selection), Waddington emphasizes the ac-

tive role of organisms in choosing and influencing their environment. And he adds: "Man, I argue, becomes moulded into an ethical being by his interactions with other members of his social group. It might be anticipated, and is in fact generally the case, that he finds great ethical value in cooperation and mutual dependence and considerably less in arbitrariness and self-sufficiency." What interactions there are between the biological and cultural evolutionary mechanisms, is not known, but Waddington concludes that for mankind "the cultural system of transmission is usually contributing incomparably more than the genetical." As far as the conditions necessary for the functioning of a socio-genetic system are concerned, the author emphasizes the role of the teacher and the taught, and the essential requirement that the taught should accept authority. He calls attention to the importance of the internalization of authority and to the ethical aspect of the nature of authority in the socio-genetic scheme.

Waddington argues that if the existence of ethical beliefs is a necessary part of the human evolutionary system, one can assign a function to these beliefs "and can therefore utilize the efficiency with which this function is fulfilled as a criterion for deciding between alternative systems of belief." These beliefs must themselves be subject to evolutionary processes. "Since we can discern their function, we can decide what is anagenesis [improvement] with respect to them, just as we can decide what is anagenesis with respect to the biological genetic system. We can attach a real and objective meaning to the idea of an improvement in the mechanism of formation and development of the super-ego as a part of the functional machinery of human evolution. This direction of improvement undoubtedly forms one of the criteria which we must apply in judging the merits of particular ethical systems."

These to the reviewer seem to be the highlights in a book which abounds in challenging speculations, and these themes are elaborated upon in considerable detail and supplemented by interesting material, providing a necessary frame, e.g., a discussion of the biological evolutionary system. There are also many asides, some of chapter length, on such subjects as logical positivism, intuitionism, and the views of various philosophers and physicists, asides which presumably mark the routes by which the author travelled, but which probably will not provide rewarding views for many readers. To many also the heavy reliance on psychoanalytic conclusions may appear less compelling than to the author.

It is one of the essential points of Waddington's scheme, and perhaps the most vulnerable one, that the emergence of a socio-genetic system in addition to the biological system marks a radical departure of human evolutionary history from the pre-human one, and that the formulation of systems of ethical values is brought about by the rational influence of teacher upon taught. Peter Kropotkin (*Anarchist Morality*, London, 1909; *Ethics*, New York, 1934), basing his conclusions in part on Adam Smith (*The Theory of Moral Sentiment*) and J. M. Guyau (*Esquisse d'une morale sans obligation ni sanction*) but chiefly on his own observations concerning mutual aid, made out a more convincing case, so it seems, for the proposition that "to seek pleasure, to avoid pain, is the general line of action (some would say law) of the organic world," a proposition which he applied very successfully to a description of the evolution of ethical instincts and their modification by rational considerations. Throughout his book, Waddington takes philosophers severely (and not unjustly) to task for their failure to come to grips with the real issues of ethics. But one hesitates to welcome the current trend to have ethical dicta promulgated by biologists in the name of evolutionary progress. As long as, *exempli gratia*, a prominent biologist can be quoted as saying that "we must convince the scientific community that chemical and biological warfare is not a dirty business. It is no worse than other means of killing" —one must doubt if biological wisdom can be trusted for the ethical guidance of mankind. Yet a critical reading of Waddington's book must be recommended as a salutary and sobering experience.

WALTER LANDAUER

SYMPOSIUM ON BASIC RESEARCH. *Sponsored by The National Academy of Sciences, The American Association for the Advancement of Science, and The Alfred P. Sloan Foundation, and presented at the Caspary Auditorium of the Rockefeller Institute, May 14–16, 1959, New York City. Publ. No. 56. Edited by Dael Wolfle. American Association for the Advancement of Science, Washington.* $3.00; $2.50 (AAAS Members). xx + 308 pp.; ill. 1959.

Basic research and sin are alike in one respect. Everyone is for the former and against the latter. Since there is general agreement not only on the desirability but also on the necessity for basic research, it seems almost redundant to belabor the topic. The participants in this conference, however, were concerned, not so much with restating and reiterating the case for the disinterested quest for knowledge, but rather with the equally pressing problems of how to pay for basic research and of how to recruit and increase the number of investigators.

The names of a few of the participants, Oppenheimer, Waterman, Beadle, Hafstad, Hinsey, Dwight Eisenhower, Killian, DuBridge, Tuve, and El-

vehjem, should suffice to underline the importance of this symposium. Its purpose "was to let the nation know of the special needs of basic research and its relationship to our future national strength and to recommend methods by which the nation might make more effective use of its potential resources for basic research."

Events in the world today lend special urgency to the conclusions reached and the recommendations for action. If the roots of the tree of knowledge are not adequately nourished and its blossoms are haphazardly pollinated, it will ultimately cease to bear fruit.

MORRIS C. LEIKIND

BIOLOGY: HISTORY AND BIOGRAPHY

LOUIS AGASSIZ. *A Life in Science.* *By Edward Lurie. The University of Chicago Press, Chicago.* $7.50. xiv + 449 pp.; ill. 1960. Edward Lurie, towards the middle of his book, asks what people thought of Louis Agassiz, and he makes his own reply: President Walker [of Harvard University] thought a museum was Agassiz's main purpose in life. Ohio fishermen thought he was determined to write a comprehensive history of American fishes; the Lazzaroni [a self-constituted group of American intellectuals desirous of influencing and improving professional science in America] thought he had joined them in an effort to control the institutional forms of science. Harvard students thought he was dedicated to their intellectual advancement. Bache [Coast Survey Superintendent] thought he was writing a report on the Florida reefs. [Lieutenant] Charles Wilkes believed he was hard at work describing the fishes gathered by the United States Exploring Expedition. Spencer F. Baird knew him as an eclectic scientist interested in any object of natural science. Sir Charles Lyell thought he was writing a masterwork on embryology. Longfellow, Felton, and Holmes saw him as a vibrant companion, anxious to plan with them the organization of a dinner club which would meet at the Parker House one Saturday each month and talk of kings, philosophy, slavery, and science. A former student visited him at Quincy Street and found him a happy domesticated naturalist. . . .The true Agassiz was, of course, everything particular individuals imagined of him.

Lurie's judgment that Agassiz was all of these things—and also more, and also less—is correct. One of the more remarkable features of his biography is that Levine follows perceptively and successfully all the tangled threads of the development of Agassiz's talents and faults within the complicated pattern of his personality while simultaneously he presents an accurate and balanced interpretation of his scientific strengths and weaknesses.

It is not the function of this review to epitomize the life of Agassiz, but it is appropriate to point out some of its complexities in order to suggest the difficulties facing any biographer who attempts to portray it. Agassiz was a European who became an American; and his European suavity endeared him to the intellectual giants in 19th century Cambridge and Boston. He began his intellectual life with a consuming interest in natural history, but he gradually abandoned his direct scientific observations in order to become perhaps the most successful popularizer of science in American history, to raise funds, and to organize. The goals of his organization lay far beyond his Museum at Harvard; he was a prime mover in the group (the Lazzaroni again) that was responsible for the establishment of the National Academy of Sciences. He was single-minded, ambitious to the point of ruthlessness, and dogmatic; he was gullible, and he was lucky, as some great men are. He began life as a romantic; he ended it as a shrewd administrator. The influences on his early intellectual life emanated from such differing minds as those of Döllinger, Cuvier, and Humboldt. When the *Origin of Species* was published, he became one of Darwin's most militant antagonists; yet in his latter days he mellowed sufficiently to become at least more objective with respect to the possibilities of alteration of species.

All of the diversified facts and facets of Agassiz's life, ideas, and accomplishments are unified by Lurie into the single figure of Agassiz as a whole man. The author plays no tricks to accomplish this. His whole tour de force is that he performs no deliberate tour de force. He assembles (and documents) the enormous wealth of material he has uncovered and presents it straightforwardly, allowing fact to build upon fact to effect his synthesis, which thus seems effortlessly attained. Surely what enabled Agassiz to be his unique self was his prodigious store of energy, which spilled over. Lurie's own energy, to collect so much information, and to organize it, must be extensive, too. But it does not spill over. The sensitivity of his understanding has permitted him to know Agassiz as a man as well as to analyze him as a scientist; it is no doubt his perceptivity in this respect that has assured him his success in bringing Agassiz to life for his readers.

Agassiz was obviously an influential man, and a great one in a limited way. He is more than fortunate to have his definitive biography written by such a skilful biographer. But scientific and other readers are also fortunate that his biographer has avoided the danger of presenting him only as a hero and has shown him as he really was. This is

not only good biography, it is good history; and it deserves comment that as history it is completely sound as to content and evaluation of scientific fact and concept. Agassiz may have been a great man in a limited way; this book, despite, or perhaps because of its unpretentiousness, is a great biography, and without limitation. It is to be hoped that it will continue to receive the acclaim that it deserves, and find its way to the shelves of all who love men, ideas, books, and nature, and whose standards fly high.

JANE OPPENHEIMER

PIONEER MICROBIOLOGISTS OF AMERICA.

By Paul F. Clark. University of Wisconsin Press, Madison. $6.00. xiv + 369 pp.; ill. 1961.

This volume is one of the most unique arrays of wanderings and wonderings in science ever compiled. The author included an accurate review of his book in the Preface. "A rambling chronicle such as this stems from everyone and everywhere. I am a part of all that I have met. I am writing this not only for students in microbiology, but also for others, who may wish to know more about this exciting period, its conflicts, its hopes, its men, and some of its achievements." General interest in this book will stem from the fact that the author has been personally acquainted with the subjects under discussion, and has gathered together a diverse assortment of interesting facts and anecdotes about persons, places, and things of the world of microbiology.

Whereas other books might lead one to believe that the development of bacteriology as a science was a very orderly process (see, for example, *Milestones in Microbiology, Q.R.B.*, 36: 1961), the closer examination provided by Paul F. Clark shows that bacteriology has had a complex, helter-skelter childhood. His book begins with a section (Foundations of Early Bacteriology, 4 chapters) on early developments in this science in Europe and America, and ends with another section (Perspective, 2 chapters) on the important societies of microbiology, and their journals and presidents, followed by an epilogue. In between are sections covering The Atlantic Seaboard (8 chapters), The Central Valley (2 chapters), and Our Western Lands (2 chapters). The volume is rich in information and references regarding the formative years of microbiology, especially medical bacteriology, in the United States during the period up to World War I. Many bacteriologists whom the younger generation might consider to be pioneers were brought up in this environment, but are not mentioned in the text because they had not come to true fame before the end of the time limit. This is the major shortcoming of the volume. On the other hand, some of the people mentioned have made substantial contributions following the period covered. Thus, the book is a story of the early pioneers, rather than a "Who's Who" of bacteriology.

One has the impression that in writing the book the author has attempted to provide answers to several questions: What qualities of the discoverer are coincident with great discoveries? What qualities of the problem had made it at first immune, then later susceptible, to attack? What qualities of the scientific environment lead to the development of scholarly graduates, a productive staff, or both? What achievements established the framework of the many branches of microbiology of today? These questions are not specifically stated. In addition, the answers are not specifically enumerated, until one reaches the Epilogue. Only here are the basic issues brought to light and the author's thoughts summarized. Regardless of the reader's scientific field of endeavor, anyone will appreciate the insight and fatherly advice given by a pioneer microbiologist of America, Paul F. Clark.

PAUL A. HARTMAN

BIOGRAPHICAL MEMOIRS OF FELLOWS OF THE ROYAL SOCIETY. *Volume 6.*

The Royal Society, London. 30s. vi + 295 pp. + 18 pl.; text ill. 1960.

Sir Archibald Vivian Hill has recently reminded us of Robert Hooke's statement of the aims of the Royal Society: "To improve the knowledge of naturall things, and all useful Arts, Manufactures, Mechanick practises, Engynes and Inventions by Experiments—(not meddling with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetorick or Logick)." Would Hooke not have approved of the philosophical bent of Agnes Arber (1879–1960), who not only interpreted structure according to typological concepts, but wrote of these concepts contemplatively as well as analytically? Would he have criticized, for all that the domain of science has altered during three centuries, as opprobriously "politickall" the extra-scientific services to their nations in time of war of Alfred Charles Glyn Egerton (1886–1959), Jean Frédéric Joliot (1900–1958), Morris Heilbron (1886–1959), or Thomas Godfray Mason (1890–1959)? And as for "Moralls," could he have failed to respect the honor of Joliot, of K. U. Lindestrøm-Lang (1896–1959), and of Max von Laue (1879–1960), who courageously refused to compromise their integrity during terrible years; and of Bruno Mendel (1897–1959), who aided so many Jewish victims less fortunate than himself? Would not his sympathies have warmed to Egerton's achievements as a painter (a color plate reproducing his painting of a river landscape in Provence accompanies his memoir), to Friedrich Adolf Paneth's (1887–1958) early pioneering in color

photography, to Lindestrøm-Lang's devotion to poetry and the violin, and to Herbert Wakefield Banks Skinner's (1900–1960) writing of poetry? And would he not have approved of the election to Fellowship in the Society of John D. Rockefeller, Jr. (1874–1960), for his contributions, of wisdom as well as money, to the advancement of scientific research?

The years 1958 to 1960 saw the deaths not only of those already named here, but also of Maurice Caullery (1868–1958), Charles Alfred Edwards (1882–1960), Karl Jordan (1861–1959), Guy Marshall (1871–1959), William Hobson Mills (1873–1959), and C. T. R. Wilson (1869–1959). Among the authors of their memorials are men as great as they: D. Keilin, P. M. S. Blackett, A. Tiselius, our own George Corner (whose memoir of Rockefeller is a particularly luminous gem), to name only a few. A note below the table of contents states soberly that "a photograph of the subject is printed with each notice." Two continental biologists are photographed with their microscopes: Lindestrøm-Lang, in his laboratory coat and with his cigar. One Briton has his pipe in his mouth, and another wears an open shirt.

Surely this whole volume sheds doubt that the self-segregation of scientists from the world and from other aspects of its culture is as divisive as is presently being vociferously deplored by a Briton who is not a Fellow of the Royal Society. It is a remarkably interesting collection of memorial biographies, and deserves wide reading for a number of reasons beyond the usual.

JANE OPPENHEIMER

ECOLOGY AND NATURAL HISTORY

OCEANOGRAPHY AND MARINE BIOLOGY. *A Book of Techniques.*

By H. Barnes. The Macmillan Company, New York. $7.00. 218 pp.; ill. 1960.

The past few years have seen a remarkable increase in interest, both among the scientific fraternity and the general public, in studies of the sea. The author states in his Preface that much of the printed material available to the reader on this subject presents factual statements about the sea, but leaves the reader in ignorance as to how these facts were established. The Preface further states that this book is primarily addressed to those who wish to learn something of how our knowledge of the sea is obtained. It is therefore a book describing instruments and techniques. In order that the description of apparatus might not become too tedious, some results of recent studies are included.

The equipment and techniques which have been and are still employed in the biological sampling of the sea are given excellent coverage. The tools employed by geologists in sampling bottom materials are also given adequate coverage. It is in the area of physical and chemical oceanography that the warning given by the author in his epilogue is most applicable. Here he states the truism "that scientific books are never completely up to date when they reach the reading public."

The use of electronic conductivity and temperature devices for the determination in situ of salinity is not covered in the text, yet these devices have been in use, both in this country and in Germany, for studies of shallow marine waters for at least six years. The Roberts current meter, developed by the U. S. Coast and Geodetic Survey, has for a number of years been utilized far more than any other device in obtaining current measurements in the marine environment in this country. It is somewhat disappointing to find so much emphasis placed on the historically significant but out-of-date Ekman current meter, while the Roberts current meter and the even newer Saronius current meter are not mentioned.

A significant fraction of this text is utilized to describe echo-sounding equipment and underwater television. While there is no question that the use of sonic fish finders by the fisheries biologist and the employment of underwater television in biological research are interesting and valuable new approaches, one feels that the rather detailed attempt to describe the basic electronic functions of both the sonic equipment and the television camera and projector was out of place in such a volume.

Despite these several deficiencies, this book will serve to fill a long-existing vacancy. I am unaware of any other published text which covers the material presented here by Barnes. It should serve to stimulate the interest of the non-specialist and of the beginning student in the problems of measurement at sea.

D. W. PRITCHARD

MARINE INFAUNAL BENTHOS IN ARCTIC NORTH AMERICA. *Technical Paper No. 5.*

By Derek V. Ellis. The Arctic Institute, Montreal. $2.00 (paper). 53 pp. + 2 pl.; text ill. 1960.

THE ECOLOGY OF ALGAE. *A Symposium held at the Pymatuning Laboratory of Field Biology on June 18 and 19, 1959. The Pymatuning Symposia in Ecology. Spec. Publ. No. 2.*

Edited by C. A. Tryon, Jr. and R. T. Hartman. Pymatuning Laboratory of Field Biology, University of Pittsburgh, Pittsburgh. $2.00. vi + 96 pp.; ill. 1960.

In this slim volume of 7 papers, the interests of the authors, all American, range from descriptive ecol-

ogy, sanitary engineering, and oceanography to experimental physiology possible only in laboratory culture. Indeed, these represent the only inroads of research on algal ecology, a subject which has been generally ignored for its lack of obvious impact on the affairs of man.

The papers of L. A. Whitford and John L. Blum present classical algal ecology, the associations of algae found in any one site at various seasons, and their correlations with range of temperature and light intensity, nutrient supply, and current. The ecological importance of the world distribution of algae and their methods of survival are only briefly mentioned by Whitford. Experimental procedures are almost totally absent within this field, and frequently descriptive material has incorporated terms from land ecology without sufficient thought as to their applicability. As Blum points out, in the microclimates of streams, where environmental conditions can change drastically in a matter of days, it seems pointless to speak of typical successions or of climax associations.

The intereffects of algae and their neighbors form the subject of papers by G. W. Prescott and Richard T. Hartman. What is known of the factors controlling algal blooms is discussed, and examples of algal poisoning, antibiotic action, and apparent interspecies antagonism or enhancement are summarized. The final paper concerned primarily with freshwater algae is that of Alfred F. Bartsch of the U. S. Public Health Service. The problems and importance of algae in controlling stream pollution and waste disposal by their production of photosynthetic oxygen are presented here.

John H. Ryther, in his paper assessing the organic contribution of marine plankton, includes a number of fairly free but entirely reasonable calculations of algal production. These make clear that although the total plant biomass of the land may be as much as a thousand times that of the sea, the annual net production of organic matter in these two major environments may be about equal. However, from the anthropomorphic point of view, much of the annual marine production must be considered a total loss, for in tropical areas of rapid turnover algae may grow and die many times without contributing to any food chain which leads to man.

The final paper, by L. Provasoli and I. J. Pintner, discusses the constitution and suitability of artificial media for the growth of both fresh and marine algae. Years of empirical research in this field are summarized by the authors in their discussion of major nutrients, trace elements and chelation, vitamin requirements, and buffers.

For the most part, the state of algal ecology has been well described by Prescott in the following words: "the surface film over a great sea of ignorance has been punctured only in a few places." The Pymatuning Symposia may perhaps lead to a remedy of this situation.

ANNETTE W. COLEMAN

THE MONARCH BUTTERFLY.

By F. A. Urquhart. University of Toronto Press in co-operation with the Life Sciences Division, Royal Ontario Museum. $6.50. xxiv + 361 pp. + 12 pl.; text ill. 1960.

The Monarch butterfly is familiar to every schoolboy who ever begins to collect insects and to most professional biologists who have been intrigued by the mysteriousness of its migration. A biography of this beloved insect was long overdue. Urquhart in offering this book has performed a labor of love. He has spent his life studying the migration of the Monarch butterfly. As a matter of fact, this book is the story of the author's work on the riddle of migration. The book not only solves many of the mysteries surrounding the movement of the Monarch from North to South America and back, but is also replete with facts about the life history and behavior of the butterfly.

The author is at his best when he is talking about migration. In other topics there are some unfortunate, though minor, lapses, such as the use of the old term "tropism" for "taxis." It is regrettable that the scent receptacle of the male is called a receptor. The experiments purporting to show that the ovipositing female can detect milkweed with her tarsi are not properly controlled and so leave the question open.

The book is anecdotal, in the style of entomological books of a century ago. Much of its charm and readability derives from this approach. It is recommended to everyone, amateur and professional alike, who has ever had an interest in the Monarch butterfly.

VINCENT G. DETHIER

LIFE HISTORIES OF CENTRAL AMERICAN BIRDS. *II. Families Vireonidae, Sylviidae, Turdidae, Troglodytidae, Paridae, Corvidae, Hirundinidae and Tyrannidae. Pacific Coast Avifauna, No. 34.*

By Alexander F. Skutch; drawings by Don R. Eckelberry. Cooper Ornithological Society, Berkeley. $15.00. 593 pp.; ill. 1960.

Alexander Skutch, working under difficult tropical conditions, has gathered a wealth of observations on the life histories of birds which is truly amazing, both in its extent and its richness of detail. Furthermore, he finds the time to write up his data in admirable form for publication. Among field naturalists, only the name of Fabre comes to mind as one searches for comparable achievements.

Most of Skutch's early contributions were widely scattered in scientific periodicals. The Cooper Ornithological Society, realizing that there would be many advantages in integrating this material into book form, initiated a series of volumes of which this is the second (I, *Q.R.B.*, 34:234. 1959). As a rough estimate, it contains about 375,000 words. The arrangement is systematic. This volume covers the families of perching birds from Vireos to Tyrant Flycatchers, and consists of a series of life histories, some of them extremely detailed. Then for each of the 8 families covered, there is a general summary of the life history of the members of the family. These summaries, which range far beyond the geographical confines of the life histories, are extremely valuable. Most of the life history studies are here published for the first time, but there are a few summaries of ones published elsewhere.

Don Eckelberry, who has had the privilege of studying Costa Rican birds with Skutch on the latter's farm in Costa Rica, has contributed charming portraits of each of the species treated. This volume should be of great value, both to the amateur and professional student of tropical birds or tropical ecology.

DEAN AMADON

A STUDY OF CERTAIN PLANT AND ANIMAL INTERRELATIONS *on a Native Prairie in Northwestern Minnesota. Minn. Museum Nat. Hist., Univ. Minn., Occasional Papers: No. 8.*

By John R. Tester and William H. Marshall. The University of Minnesota Press, Minneapolis. Free upon request (paper). viii + 51 pp.; ill. 1961.

EVOLUTION

THE MORPHOLOGY AND ANATOMY OF THE AMERICAN SPECIES OF THE GENUS *Psaronius. Illinois Biol. Monogr.: No. 27.*

By Jeanne Morgan. The University of Illinois Press, Urbana. $4.00. viii + 108 pp. + 81 pl. 1959.

In spite of the fact that *Psaronius*, a Paleozoic arborescent fern genus, was first described in 1832, its complex stelar morphology has always been perplexing to paleobotanists. By assembling an impressive number of well-preserved American specimens of *Psaronius*, Jeanne Morgan has attempted to interpret stages in the ontogeny of an entire plant. She demonstrated that at the base of one of these tall ferns the stem was rather narrow, with a small number of stelar cycles, few leaf orthostichies, and a spiral leaf arrangement, and that the stem was surrounded by a massive root mantle. The obconical stem had more stelar cycles above, more rows of leaves, and a thinner root mantle; in the distal portions of a mature plant, leaves were borne in whorls.

It thus becomes obvious that what had been called numerous "species" of *Psaronius* by earlier workers actually represent various parts of the stems of a smaller number of species.

Illustrations are effective and beautifully reproduced; both line drawings and sharp photographs help to make the technical portion of the text more understandable. It is unfortunate, however, that illustrations could not have been interspersed throughout the text rather than having been grouped at the end.

This publication represents a significant paleobotanical event because it is an attempt to deduce the ontogeny of fossil forms, and it regards each fossil fragment as a portion of a once-living, dynamic, evolving group rather than simply a rock with interesting and curious patterns in it.

THEODORE DELEVORYAS

HISTORY OF THE PRIMATES. *An Introduction to the Study of Fossil Man. Seventh Edition.*

By Sir Wilfrid Le Gros Clark. British Museum (Natural History), London. 5s. (paper). viii + 119 pp.; ill. 1960.

Although described as a new edition, the updating of this version of the standard and excellent British Museum booklet on the *History of the Primates* has been sensibly changed only by the addition of three brief references. One of these is to the discovery of a frontal bone presumably belonging to the Oligocene ape *Parapithecus*; a second is a depreciatory, or at least slighting, reference to *Oreopithecus*, which on the basis of recent studies is probably the major primate find of the past decade; and the third is a reference to the discovery by the Leakeys of pebble-tools at Olduvai Gorge, in association with australopithecine remains. No one who has a copy of the 6th edition of this guide will need to replace it; and a real revision of current knowledge and opinion on the basis of the more recent studies will be needed ere long. Nevertheless, for the general reader this booklet remains one of the best, and assuredly the least expensive, guides to the study of fossil man, his ancestors, and collaterals.

BENTLEY GLASS

BRACHIOPODS OF THE TRAVERSE GROUP (DEVONIAN) OF MICHIGAN. *Part I. Dalmanellacea, Pentameracea, Strophomenacea, Orthotetacea, Chonetacea, and Productacea. Bull. Amer. Museum Nat. Hist., Vol. 116, Art. 4.*

By John Imbrie. American Museum of Natural History, New York. $1.75 (paper). iv + pp. 349–409 + pl. 48–67; text ill. 1959.

GENETICS AND CYTOLOGY

GENETICS. *Genetic Information and the Control of Protein Structure and Function. Transactions of the First Conference, Oct. 19, 20, 21, and 22, 1959, Princeton, N. J.*

Edited by H. Eldon Sutton. Josiah Macy, Jr. Foundation, New York. $6.00. 229 pp.; ill. 1960.

Research on nucleic acids reached a milestone, some eight years ago, with the description by Watson and Crick, of a structure for DNA which both fitted the facts of chemistry and allowed a framework of testable hypotheses to be formulated for its replication and functioning in supervising the formation of specific proteins. The outgrowth of this development, coupled with the "one gene-one enzyme" hypothesis of Beadle and Tatum, is the current creed, or as it is referred to in the volume, "The Dogma," of present-day molecular genetics. That the creed which pervades genetics is truly a dogma is evident from the fact that it is central to the theme of this symposium yet awaits page 106 for the first clear statement of it, elicited by a perhaps impatient request: "... there is a 1 to 1 correspondence between position on the genetic map and position along the polynucleotide chain of the DNA. Furthermore, it is assumed that the order and the relative distances of mutations along the genetic map is a direct reflection of the order and relative distances of alterations in the polynucleotide chain.... The second item of the 'dogma' is that DNA controls the primary structure of proteins ... the gene is a one-dimensional structure and the only evident thing about a protein which is one-dimensional is the primary sequence of the amino acids along the peptide chain."

Three operationally distinct problems, differing greatly in the magnitude of the effort necessary for their resolution, arise from the creed. First of all, the general principles of the creed still await a more absolute verification. This is by far the easiest problem to solve and one which, as was so clearly brought out in the symposium, is supported by a wealth of indirect data and is within our grasp of conclusive demonstration. Its validity is fundamental to real progress in the other two related and more difficult problems. These two problems are the "cracking of the code" itself, and the relation of fine-structure genetics to the complex structures constituting the chromosomes of various organisms. Translation of the nucleic acid code (i.e., precisely which base sequence dictates which amino acid) is an enormous undertaking for which molecular genetics is just "tooling up." Perhaps the answer will come from one of the gene-protein systems described in this volume. More probably, however, it will come from an entirely different source, such as the small RNA and DNA viruses, from analyses of base sequences in amino acid "transfer" RNA, or from a source not yet anticipated.

The excellent discussions in the first two chapters of this book illustrate how rapidly the creed is maturing. The final chapter serves to illustrate the hodge-podge of thinking and experimentation that surrounds modulation of biochemical expression, particularly with regard to enzyme adaptation and repression, an area clearly awaiting success with cell-free enzyme-forming systems for critical examination.

The first discussion, led by J. D. Watson, concentrates on DNA structure and on its replication. A number of systems which are contributing toward our understanding of the genetic control of protein structure are extensively discussed in the ensuing two chapters. These include emphasis on human systems, such as the hemoglobins (V. M. Ingram), haptoglobins (O. Smithies), and glucose-6-phosphate dehydrogenase (P. A. Marks), as well as microbial systems, such as bacterial alkaline phosphatase (C. Levinthal) and phage lysozyme (C. B. Anfinsen).

PHILIP E. HARTMAN

PAPERS ON BACTERIAL GENETICS.

Selected by Edward A. Adelberg. Little, Brown & Company, Boston and Toronto. $4.50 (paper). xlvi + 400 pp.; ill. 1960.

In 1951 Lederberg compiled a collection of 20 published papers dealing with the genetics of bacteria and bacterial viruses (*Q.R.B.*, 27:391. 1952). That book has been of considerable aid to teachers of microbial genetics, because it makes easily available to students a cross-section of the original literature. During the years following its publication, genetical research with bacteria and phages was greatly extended, a number of new techniques were developed, and several basic discoveries were made. Consequently it became desirable to prepare another, more up-to-date collection of papers. This work has been successfully accomplished in the present volume edited by Adelberg, and containing 27 studies in bacterial genetics, together with its companion volume of papers on bacterial viruses, which is being issued separately.

The Adelberg collection includes papers dealing with three groups of problems: mutation (spontaneous and induced, mechanisms of mutation in terms of DNA, and population dynamics); intercellular

transfer of genetic material (transformation, transduction, phage conversion, conjugation, and the sex factor); and genetic determinants (complex loci, genes of structure and genes of regulation, and episomes).

To compensate for the necessarily incomplete and arbitrary nature of the selection, the volume is prefaced by a 37-page introductory text and bibliography (177 items) that afford a historical review of the problems considered in the collection. This introduction provides a well-rounded picture of certain phases of the work in bacterial genetics, and helps bring unity to what otherwise might appear as a series of disconnected presentations of original work. Particularly well reviewed is the section on conjugation, an area to which the editor's own research has significantly contributed. In his discussion of rate of mutation to phage resistance per bacterial division cycle, however, the editor credits the spraying technique to Newcombe, whereas that technique was published several years before Newcombe's work was done, and was used also by G. H. Beale (*J. Gen. Microbiol.*, 2:131. 1948) in his elegant analysis of spontaneous mutation rates, the first to be carried out by this method. It seems unfortunate, too, that H. Moser's work on the dynamics of bacterial populations (*Carnegie Inst. Wash. Publ.* 614, 1958, 136 pp.) is not mentioned in the discussion of population dynamics, since it is one of the most comprehensive studies available in the field. It also seems confusing to use the term "cistron" to designate a unit that controls the formation of an individual enzyme.

Both the Introduction and the collected papers should furnish very useful reference materials to students in courses that include the field of bacterial genetics.

M. Demerec

Symposium on Mammalian Genetics and Reproduction. *Given at Research Conference for Biology and Medicine of the Atomic Energy Commission held at Gatlinburg, Tenn., April 4–7, 1960. J. Cellular Comp. Physiol., Vol. 56, Supp. 1.*

Introduction by Alexander Hollaender. Oak Ridge National Laboratory, Oak Ridge. Limited number (free). x + 193 pp.; ill. 1960.

This volume, containing 12 papers, is the thirteenth in a series of yearly symposia on biological research sponsored by the Biology Division of the Oak Ridge National Laboratory. Three of the contributed papers deal with the formation and function of gametes. B. Mintz traces the cells of the germ line from embryonic into postnatal life. She uses the results of radiation studies and histological examinations for experimental evidence on the genetic control of developmental processes. A. W. H. Braden discusses the genetic influences on gamete function, referring mainly to studies on one of the best-known examples in mammals, the *t* locus in mice. An interaction between maternal and paternal genotypes influences the transmission ratios at this locus. C. R. Austin demonstrates three anomalies of fertilization that lead to triploid embryos and gives the possible consequences and frequency of occurrence.

Two studies concern the nature of gene action and the relation between genes and their products. S. Gluecksohn-Waelsch uses mouse hemoglobin types to investigate these problems and reviews related work in other species. H. B. Chase and S. J. Mann discuss studies on basic gene action at the developmental level, using the hair and pigment mutants in the mouse for illustration. A detailed account of the *dilute–short-ear* region on the second chromosome of the mouse is given by L. B. Russell and W. L. Russell. This analysis is based on studies of mutants found in the radiation work at the Oak Ridge National Laboratory. A. B. Griffen outlines methods and techniques for mapping pachytene chromosomes and identifying linkage groups in the mouse. His paper includes figures of the mouse chromosomes.

Two papers are devoted to problems in quantitative inheritance. D. S. Falconer analyses the components of litter size as revealed in experiments with two-way selection, inbreeding, and control lines, and he discusses the relative influence of the maternal and individual genotypes. S. Wright explores the relationship among the vital characteristics of the guinea pig by path analysis of these traits in inbred and crossline groups. He also illustrates various abnormalities found in his extensive inbreeding experiments with guinea pigs.

Three reviews of general areas of mammalian genetics are included. H. Grüneberg surveys the present status of developmental genetics in the mouse and suggests promising approaches to the remaining problems. W. F. Hollander covers the relationship between genetics and reproductive physiology, and emphasizes the diversity among species in their methods of reproduction. R. D. Owen summarizes the present activity in the field of mammalian immunogenetics.

This symposium demonstrates the wide range of disciplines concerned with research on mammalian genetics and reproduction. Cytogenetic studies, developmental and physiological genetic problems, and investigations of quantitative inheritance are included to give a broad and balanced view of current activity. Although mammalian genetics is studied from many points of view, only a few mammalian species are used in such experiments. With the notable exception of S. Wright and the necessarily brief reviews by other authors, the volume is devoted to the genetics of the mouse. Mice are admirably suited for experimental work and will

probably continue to be the most intensively studied mammal. However, this group of papers emphasizes the need for studies conducted with other mammals, especially when they might be ideal for types of experiments that are difficult or impractical with mice.

The open discussions that followed each paper are included. These reflect the general interest and enthusiasm that was evident at the meeting. Often they include supporting evidence from other work. The book is recommended to workers in mammalian genetics both for its clear and concise presentation of recent investigations and for its extensive review of current research.

D. F. Cox

NEW APPROACHES IN CELL BIOLOGY. *Proceedings of a Symposium held at Imperial College, London, July 1958.*

Edited by P. M. B. Walker. Academic Press, New York and London. $6.00. viii + 205 pp.; ill. 1960.

The central problems of cytology were pretty well formulated by the turn of the century, as was the conviction that their solutions were to be found in the refinement of the analysis which began with the perfection of light-microscopy and the discovery of the chief macromolecules out of which the cell is fabricated. The shades of a Mieschcr, a Flemming, a Verworn, or a Wilson must feel at home and quite pleased with the developing state of affairs, and if they are a little offended by the implications that *New Approaches In Cell Biology* are really new approaches, we may patiently explain to them that contemporary science is not entirely innocent of the vocabulary of advertisement.

This volume is the record of a symposium held in London in 1958 on the occasion of the Fifteenth International Congress of Zoology. As the editor, himself an active representative of the "new cytology," points out, it was appropriate that a symposium held under such auspices should represent the main currents of cytological tradition. It does in fact illustrate the continuity and progress of these currents quite well, while omitting certain other developments which have lately donned the prestigious uniform of "molecular biology."

A survey of the contents of this volume will illustrate what is new and what is not. Transplantation of nuclei was described by Verworn in 1892 (unsuccessful) and by Commandon and de Fonbrunne in 1938 (successful). The reasons for carrying out such transplantations were the same as those which motivated J. A. Moore and J. F. Danielli, who contribute chapters on interspecific nuclear transfers in eggs and in amebae: to evaluate the control functions of nucleus and of cytoplasm. The technical refinement and sensitivity of criteria of the newer workers demonstrates a surprising degree of influence of cytoplasm upon the ability of the nucleus to dictate the character of a cell. A paper by Callan and Lloyd, on lampbrush chromosomes, illustrates the high degree to which the microscopic behavior of these chromosomes, whose existence was known in 1892, is an expression of their genetic activity. A chapter by Waddington, dealing with the fine-structure of differentiating systems, reminds us that differentiation is not only a matter of enzyme synthesis, but also a matter of making structure. The "new approach" here is obvious and is bound to be increasingly informative; the electron microscope sees structure as we could not see it before. J. Boss summarizes an important and often-neglected problem of mitosis: the restoration of the interphase nucleus after mitosis is over. Again, the electron microscope can solve many of the problems, and it is satisfying to consider how much has been done, especially on the origin of the nuclear membrane, since this chapter was written. A chapter by R. M. Clayton is one of the best summaries the reviewer has seen of the study of differentiation by immunochemical techniques, especially with the aid of the now-indispensable fluorescent-labeling procedures. Here, perhaps, one can say that a truly new approach—the use of tracers and labels—is illustrated, one for which it is not so easy to find ancient precedents. In the same spirit, A. Buzzati-Traverso outlines the potentialities of chromatography for correlating genetic differences with chemical differences.

Cytochemistry in Mieschcr's sense—he used the term histochemistry but himself thought mainly of a chemistry that was referred to parts of cells—certainly represents a major tradition of cytology, one whose development was and is limited by the availability of methods to match our aspirations. The current status is illustrated by W. S. Vincent's chapter on the nucleolus, by E. A. Barnard's chapter on the cytochemistry of protein, and by C. Leuchtenberger's chapter on the cytochemistry of nucleic acids. The status is this: we can now identify and measure reasonably well all of the main *classes* of macromolecules, and are beginning to be able to push toward analysis of particular chemical groupings in these molecules. For example, Vincent demonstrates by end-group methods that the qualitative composition of the proteins of the nucleolus is unexpectedly simple. The need for an optical means of "weighing" parts of cells, realized in the interference microscope as described by A. J. Hale, was fully foreseen in older work, in which inferences concerning mass were made from measurements of volume. Nor would the potentialities of flying-spot microscopy, as described by W. K. Taylor, require much explanation to our predecessors who lived by the microscope.

This volume, then, is a sampler of contemporary

cytology. It is not intended to be complete nor can it be unique, for the subject matter is popular among organizers of symposia. The chapters are brief and well written. As the editor points out, this new cytology in the old tradition now coexists and interacts with another kind of cell biology whose fountainheads are genetics, biochemistry, and microbiology. The bottle of cell biology should, in the future, be an interesting blend of new wine, old wine, and old wine that has been processed by new machines.

DANIEL MAZIA

GENERAL AND SYSTEMATIC BOTANY

THE STORY OF THE PLANT KINGDOM.

Original Edition by Merle C. Coulter; revised by Howard J. Dittmer. The University of Chicago Press, Chicago. $5.00. x + 326 pp.; ill. 1959.

This "Chicago" text differs conspicuously from the original edition in many ways (*Q.R.B.*, 11:242. 1935). The subject matter is rearranged, some topics (e.g., the modern plant body) are expanded, chapters are rewritten to different degrees, new chapters on growth and heredity are added, and the classification in which major groups are treated as phyla is adopted. Prominent changes in format include the use of chapter subheadings and boldface type for important terms. A geologic time chart, sections on economic importance in most chapters, word outlines of life cycles, and 3 pages of supplementary reading references are other new features. The illustrations are largely those of the original edition, and the phylogenetic approach is again emphasized, although different lines of descent are recognized.

The additions and rewritten portions generally adhere to the original style and, as stated in the Preface, an effort has been made to keep technical terminology to a minimum. Difficulties associated with tendencies toward simplification and abbreviation are reflected in different ways. The endodermis of roots is described as a layer and subsequently referred to as a ring of cells, and the cambium in roots "begins as a few small brick-shaped cells." In the brief treatment of wood structure many fundamental features are omitted, and those which concern vessels, tracheids, and lignification are not clearly delimited. One notes that dendrology is stated to be the study of tree rings, and that *Equisetum* gametophytes are described as differentiated into male and female individuals, as in the first edition, despite observations to the contrary.

Following the pattern of the earlier edition, aspects of the cell are introduced in the first chapter, *Gleocapsa* being chosen as an example. Since the nucleus is not introduced here, the index was consulted and the first reference to the nucleus was found to be on p. 73, where cell division is discussed. Inspection revealed, however, that the presence and absence of nuclei in companion cells and sieve tubes of phloem, respectively, are emphasized on p. 51.

Such shortcomings as have been cited do not characterize the entire book, which is intended for an elementary one-semester course. Without doubt the volume adheres to and supplements the story of the plant kingdom that made a success of the first edition. Although described on the jacket as "revised and reorganized to include important developments in modern botanical research," only the net effects of photosynthesis and respiration are emphasized, and the index lacks such items as mitochondria, DNA, RNA, and vitamins. It may be questioned whether it would not have been advantageous to add more.

CHARLES HEIMSCH

CYANOPHYTA.

By T. V. Desikachary. Indian Council of Agricultural Research, New Delhi. $11.00. x + 686 pp. + 139 pp.; text ill. 1959.

Here is a big and, by present-day standards for scientific works, sumptuous tome, a compilation of almost everything hitherto published, with some new material, on the blue-green algae of Greater India. It is one of a series of large treatments of various groups of algae now being issued by the Indian Council of Agricultural Research. Sixty-seven pages at the beginning are devoted to a summary of the contributions of numerous workers throughout the world on the morphology, physiology, ecology, and the more speculative aspects of classification of the Myxophyceae. Desikachary passes swift judgment upon each of these researches, even those which are likely to remain for many years controversial. The systematic part follows, beginning with a brief historical account, curiously not of the exploration in India for blue-green algae, but of the publication of records of these plants. After this come 544 pages of description, with keys for identification, of the taxa involved, which include "about 750 species." Because most of the specimens concerned are presumably in Indian collections, we might expect that, in a volume describing so authoritatively a large and important flora, the author should select type specimens for at least the numerous endemic taxa and reinterpret them. To our disappointment, the text indicates very few specimens which the author has studied at all. Two new species of *Microcystis* and *Chroococcidiopsis* are described in Latin, along with 3 new varieties in *Arthrospira, Phormidium,* and *Mastigocladus* and 5 new forms in *Dactylococcopsis, Arthrospira, Spirulina,* and *Oscillatoria.* In addition, sundry new

names, each misleadingly labeled "nom. nov.," are introduced with English, but not Latin, descriptions. All species and subspecific taxa are illustrated with line drawings, most of them copied from those of other authors. Desikachary concludes the book with 38 pages of general and local bibliographies, which will surely be very useful to students of algae in the future, and with separate indices to the general and systematic parts of the work.

FRANCIS DROUET

INDEX MUSCORUM. *Regnum Vegetabile, Volume 17. Volume 1 (A–C).*

Edited by R. Van Der Wijk. The International Bureau for Plant Taxonomy and Nomenclature, Utrecht. $8.00. xxviii + 548 pp. 1959.

Well over a half century has elapsed since the publication of the last comprehensive catalogue of the mosses of the world, the second edition of Paris' *Index Bryologicus*. At the International Botanical Congress in Brussels in 1910, bryologists adopted Hedwig's *Species Muscorum* (1901) as the starting point for the nomenclature of Musci (mosses), in place of Linnaeus' *Species Plantarum* (1753). This change in starting point required many changes of name, which, combined with the discovery and description of thousands of new species since 1901, has for many years made a revised index to mosses urgently necessary.

At the International Botanical Congress at Cambridge, in 1930, the bryologists recognized the need for a new index, and in 1935, a statement was published to the effect that the compilation of such an index would be started under the auspices of the International Union of Biological Sciences. The death of its moving spirit, H. N. Dixon, in 1944, suspended activity for a decade in this direction. The Bryology Section of the International Botanical Congress held in Paris, in 1954, agreed that the new index should contain all names of Musci published from 1801 up to the present, that it should reconcile the nomenclature of all mosses with the present International Code of Botanical Nomenclature, and that it should contain all information needed to apply the type method. With subsidies from the Dutch Organization for Pure Research and the U. S. National Science Foundation, work started seriously in 1956. This volume, the first of five, appeared in 1959, in time to be displayed at the International Botanical Congress in Montreal.

Thanks to careful planning and highly explicit introduction to the various symbols and typographic usages, much information concerning each species is given with the utmost conciseness.

This volume—and the completed work—will be indispensable to botanists, librarians, information centers, and especially, of course, to bryologists. The author(s), place and date of publication, present status, synonymy, and broad geographical distribution are given for each genus, species, and variety listed. It would be helpful to have also the citations for higher categories, which these same authors may eventually give us in a supplementary publication.

WILLIAM C. STEERE

PLANT MORPHOLOGY AND DEVELOPMENT

GRUNDZÜGE DER HISTOGENESE HÖHERER PFLANZEN. *I. Die Angiospermen. Handbuch der Pflanzenanatomie. Abteilung: Spezieller Teil. Band VIII, Teil 3.*

By Herman von Guttenberg. Gebrüder Borntraeger, Berlin. DM 110.- viii + 315 pp.; ill. 1960.

In the last several decades developmental plant anatomy has been studied intensively on three continents—Europe, North America, and Asia. The origin of tissues, especially in higher plants, has been subjected to very careful scrutiny, in some instances by the use of recently developed techniques, including that utilizing C^{14} and autoradiographs. A volume which brings together much of this literature, with a critical discussion of some of its controversial aspects, is both timely and valuable.

After a general introduction in which meristems, initials, histogens, and the formation of histogen initials in the embryo are considered, the book is divided into 4 main chapters. In the first the development of the root is taken up; the second deals with the development of the shoot; the third with the development of the leaf; and the fourth with the differentiation of the histogens in the stem and the leaf. Each of these chapters is a detailed presentation, in which these structures are carefully traced from their earliest beginnings. Although there are differences in a group of plants as diversified as the angiosperms, the author succeeds remarkably well in emphasizing fundamental similarities, and in following progressively the cell-by-cell story. To the understanding of these his own research has added in no small measure. The book concludes with a bibliography of 11 finely printed pages which includes both classical and modern references, a subject index, an index of the families, subfamilies, genera, and species treated, and an author index. The European literature, especially, is carefully evaluated. The volume is well illustrated, with 328 text figures, many of which are from the author's own work. In his closing reflections, the author decides, on histogenetic grounds, that the Nymphaeaceae belong to the monocotyledons, that the evidence strengthens the concept of relationship between the grasses and the Commelinaceae, and

that in certain developmental features *Casuarina* is strikingly similar to the conifers.

The author has given a clear and forceful presentation of an intricate and expanding subject. There will be some who disagree with certain of his convictions, but after all this is his book, and it is an exceedingly good one.

EDWIN B. MATZKE

COMPARATIVE MORPHOLOGY OF VASCULAR PLANTS. *By Adriance S. Foster and Ernest M. Gifford, Jr.; drawings by Evan L. Gillespie. W. H. Freeman & Company, San Francisco.* $9.00. xii + 555 pp.; ill. 1959.

This textbook aims to provide a factual description of the main groups of vascular plants and to present the procedures, general principles, and objectives of comparative morphology. Earlier textbooks have not been as explicit in handling the latter which have been formulated by many investigators. This new book should hold special value for the student because of its treatment of these background fundamentals and because all groups of vascular plants are considered. Many, if not most, botany curricula include a course which demands the coverage of this subject, but in the past it has been necessary to use several textbooks which always differed in emphasis and elaboration. Throughout the present book, treatment is more uniform and reflects the same high quality that has characterized the personal researches of the authors.

Approximately equal portions are devoted to 5 main categories of content. The first 6 chapters provide the orientation and background in morphological principles; separate chapters on the Psilopsida, Lycopsida, and Sphenopsida follow. Four chapters are concerned with the general characterization of the Pteropsida and a detailed treatment of ferns. Gymnosperms are likewise covered in 4 chapters. The last 2, relatively long chapters present general morphology and evolution and the reproductive cycle in angiosperms.

Inclusion of important contributions to comparative morphology from studies in embryogeny, experimental morphogenesis, histogenesis and other areas is of particular merit. There has been an urgent need in morphological instruction for interrelating the findings in these fields and for interpreting their significance with respect to other fundamental subject matter. In addition, the attention given to the contributions of comparative anatomy and the significance of the comprehensive studies among the woody Ranales are also noteworthy. Literature citations are made throughout the text, complete references being given at the end of each chapter. The student is repeatedly referred to the original papers for additional details. Information from fossils is included, but doubtless there will be some who would prefer added emphasis in this area. Many instructive drawings by Evan L. Gillespie, along with a large number of excellent photographs, complement the text effectively.

Typography and other aspects of organization reflect care on the part of the authors and publisher. In the only text error noted, early adventitious roots of corn seedlings are labeled as lateral roots (Figs. 19–28). Attention given to the index was apparently less critical, since several misspellings occur in it. Index entries are generally of a descriptive style in order to be of maximum usefulness, and although cross references are numerous, citations that might be deemed desirable are often omitted. In more than a few cases multiple second-order entries are given for primary topics that cover only a few pages. Whereas this practice affords information as to focus and emphasis, more explicit attention to entries for certain broad topics such as homology and phylogeny could have been given.

The valuable initial chapters on morphological principles may present difficulty to users of the book because frequent use is made of examples before a sufficient background of knowledge is developed in regard to specific plants and the groups to which they belong. Experience with the book would be needed in order to evaluate this judgment. In view of the broad area of subject matter covered, the problems in limiting the scope of the treatment can be truly appreciated. Some may feel that many subjects are touched upon too lightly or may deplore the lack of specific discussion of certain fossil groups and of such topics as the nature and origin of microphyllous leaves of the Lycopsida and Sphenopsida, the sphenopsid cone, or the phylogeny and anatomical delimitations of the conifers, but few will consider that there are any critical omissions.

If all aspects of the book are held in proper perspective, the volume unquestionably represents an outstanding contribution. It fills a real need and should contribute significantly to instruction in plant morphology.

CHARLES HEIMSCH

ECONOMIC BOTANY

TROPICAL AND SUBTROPICAL AGRICULTURE. *Two Volumes.*

By J. J. Ochse, M. J. Soule, Jr., M. J. Dijkman, and C. Wehlburg. The Macmillan Company, New York. $35.00 (set). (Vol. 1) liv + 760 pp.; ill.; (Vol. 2) xxii + pp. 761–1446; ill. 1961.

In the minds of many people, the tropics represent a reservoir of land and resources that is capable of

furnishing food, fibers, fuel, and other raw materials for large numbers of people. As the population pressure has increased in the temperate zones, there has been a feeling that the tropics represent a safety valve and that future development of these areas will provide for an unlimited increase in the world's population. There is little scientific information, however, to substantiate these beliefs, and it is becoming increasingly evident that we need a great deal of fundamental research on tropical and subtropical problems. There has been no lack of research on tropical problems, but most of the research has been directed towards the solution of practical problems. The literature on such matters is voluminous and widely scattered. The new two-volume treatise *Tropical and Subtropical Agriculture* is of value because it brings together in a single work a great deal of the pertinent literature.

The first part of the work covers such general problems as climate and physiography, soil problems, methods of crop improvement, and propagation methods. Each of these subjects is, in itself, material for a separate monograph. The authors have succeeded rather well in bringing together the important literature on these matters. It is particularly noticeable that many modern research methods and techniques have not been widely used in the tropics.

The balance of the work is given over to a consideration of the crops of the tropical and subtropical areas. These crops include fruits, spices, beverages, rubber, cinchona, oil crops, fiber crops, and field crops such as sugar cane, rice, maize, and tobacco. The coverage for the different crops varies considerably; there are 25 pages on bananas, 100 pages on citrus, and 4 pages on peanuts. For each crop the common names are given in English, Spanish, Dutch, French, German, and Portuguese. There then follows a botanical description and, in many instances, specialized information on world production, cultural methods, commercial varieties, climatic and soil requirements, harvesting, diseases, and other pests. Each of these sections on the various crops is amply documented with literature citations, particularly the Dutch literature, since two of the authors had extensive experience in the Dutch tropics. There is a useful glossary, an index of common plant names, and a very complete author and subject index.

G. Ray Noggle

GENERAL AND SYSTEMATIC ZOOLOGY

Fortschritte der Zoologie. *Im Auftrage der Deutschen Zoologischen Gesellschaft. Band II. Edited by Max Hartmann. Gustav Fischer Verlag, Stuttgart.* DM 46.- iv + 353 pp.; ill. 1958.

This volume of the *Fortschritte der Zoologie*, which has rapidly resumed its place in biological literature as foremost among the zoological reviews, contains 6 articles. The first is a rather brief review of the morphology and development of invertebrates covering the period 1945–1955, by Gerhard Czihak. There follows a much longer review of animal geography, 1950–56, by Günther Niethammer. Three related articles cover respectively the physiology of movements and the movements of parts of animal cells (Hoffmann-Berling); nerve physiology (Friedrich P. J. Diecke); and the central nervous system (Erich von Holst). The final review, covering the subject of ecology, is by W. Kühnelt. Each review has a comprehensive bibliography.

Annual Review of Entomology. *Volume 6. Edited by Edward A. Steinhaus and Ray F. Smith. Annual Reviews, Palo Alto.* $7.00. viii + 470 pp.; ill. 1961.

Contents: Darwin's contributions to entomology (J. E. and C. L. Remington); Insect nutrition (H. L. House); Nutritional factors in insect resistance to chemicals (H. T. Gordon); Principles of insect cold-hardiness (R. W. Salt); Biochemistry of insect hemolymph (G. R. Wyatt); Role of mitochondria in respiratory metabolism of flight muscle (B. Sactor); Diurnal rhythms (J. E. Harker); The theoretical and practical study of natural insect populations (O. W. Richards); Principles of insect predation (C. S. Holling); Biological control of pest insects in Europe (J. M. Franz); Sampling crop pests and their hosts (A. H. Strickland); Biology of chiggers (M. Sasa); The phenomenon of industrial melanism in Lepidoptera (H. B. D. Kettlewell); A review of the phylogeny of mites (T. A. Woolley); Palaeoentomology (O. Martynova); Analysis of insect embryogenesis (S. J. Counce); Chemistry of organic insecticides (T. R. Fukuto); Mode of action of insecticides (C. C. Roan and T. L. Hopkins); Ecological aspects of plant virus transmissions (W. Carter); Mechanism of transmission of viruses by mosquitoes (R. W. Chamberlain and W. D. Sudia); Arthropod vectors as reservoirs of microbial disease agents (C. B. Philip and W. Burgdorfer); Transmission of filarioid nematodes (F. Hawking and M. Worms).

There are the usual subject and author indices, and in addition indices to chapter titles and authors in Volumes 2 (sic) through 6. Unlike earlier numbers, in this one the contributions for the next volume are not listed.

In the Preface the editors debate the advisability of beginning to include titles in the bibliographic citations and request of readers their opinions, while pointing out that in one way or another either the number of text pages will be cut or the cost in-

creased. Here is one vote for the inclusion of titles: sometimes they tell more than a reviewer's cryptic statement, they always supplement it, and very often they save a trip to the library. As for fewer text pages, it seems unlikely that the editorial board in these days is flooded with worthy ideas for review topics and is besieged by prospective reviewers.

DAVID R. EVANS

NEW PSEUDOCOCCIDAE (HOMOPTERA: COCCOIDEA) FROM AFRICA. *Bull. Brit. Museum, Entomol., Vol. 10, No. 6.*

By G. De Lotto. The British Museum (Natural History), London. 25s. (paper). ii + pp. 212–238 + pl. 20–49. 1961.

LES ANOPHÈLES DU MAROC. *Mém. soc. sci. nat. Maroc, nouvelle sér., No. 7.*

By Yves Guy. Societé des Sciences Naturelles et Physiques du Maroc, Rabat. (paper). 224 pp. + 42 pl.; text ill. 1959.

This is strictly a taxonomic review of the species of *Anopheles* found in Morocco. Its purpose is to serve as a ready guide to these species. The adult larvae, pupae, and eggs of the 9 species and subspecies known to occur in Morocco are described in detail, and there are notes on distribution and biology. Pertinent morphological notes are included of several anophelines which may some day be found in Morocco. Keys and illustrations complete the aide to identification. The pamphlet should be of use to those who find it necessary to identify the anophelines of Morocco.

L. E. ROZEBOOM

A TAXONOMIC STUDY OF THE LARVAE OF WEST AFRICAN SIMULIIDAE (DIPTERA: NEMATOCERA) WITH COMMENTS ON THE MORPHOLOGY OF THE LARVAL BLACK-FLY BIRD. *Bull. Brit. Museum Entomol., Vol. 10, No. 1.*

By R. W. Crosskey. The British Museum (Natural History), London. 21s. (paper). ii + 74 pp.; ill. 1960.

A REVISIONAL STUDY OF THE BEES OF THE GENUS *Perdita* F. SMITH, WITH SPECIAL REFERENCE TO THE FAUNA OF THE PACIFIC COAST. (*Hymenoptera, Apoidea*). *Part IV. Univ. Calif. Publ. Entomol., Vol. 17, No. 1.*

By P. H. Timberlake. University of California Press, Berkeley and Los Angeles. $3.00 (paper). ii + pp. 1–135 + 17 pl. 1960.

Part IV treats the numerous species of the Octomaculata group of the subgenus *Perdita*. The high quality of the three previous parts is maintained in the present contribution.

KARL V. KROMBEIN

A TAXONOMIC AND BIOLOGICAL STUDY OF THE GENUS *Xyela* DALMAN IN NORTH AMERICA. *Univ. Calif. (Berkeley) Publ. Entomol., Vol. 17, No. 3.*

By Donald J. Burdick. University of California Press, Berkeley and Los Angeles. $1.50 (paper). iv + pp. 285–353 + 1 pl.; text ill. 1961.

CHECK-LIST OF BIRDS OF THE WORLD. *A Continuation of the Work of James L. Peters. Volume IX. Edited by Ernst Mayr and James C. Greenway, Jr. Museum of Comparative Zoology, Cambridge.* $7.50. xii + 506 pp. 1960.

This is the first volume of this important reference compendium to be issued since the death of James L. Peters, who began the series in 1930 and who brought out the first seven volumes alone. The eighth volume, covering the American tyrant-flycatchers, has not yet been published, but its preparation is well advanced. The present volume contains contributions by 11 authors covering some 16 families of birds. The accounts of a few small families are presented as their respective authors wrote them, but those of the larger groups were read and criticized in manuscript by one to six specialists.

The presentation of the material follows the pattern established by Peters in the earlier volumes, although a binomial designation has been added for each species, and, in the case of every species that has a well-known English vernacular name, this has also been included. The avian families covered in the present volume are the larks, Alaudidae; the swallows, Hirundinidae; the wagtails and pipits, Motacillidae; the cuckoo-shrikes, Campephagidae; the bulbuls, Pycnonotidae; the leaf birds, Irenidae; the shrikes and their allies, Laniidae; the vangas, Vangidae; the waxwings, Bombycillidae; the palm-chats, Dulidae; the dippers, Cinclidae; the wrens, Troglodytidae; and the mockingbirds and thrashers, Mimidae. As in the earlier volumes of the series, all synonyms subsequent to Sharpe's *Hand-List* are cited. The manuscript was closed to additions or alterations as of July 1, 1958, so the volume is up to date to within two years of its appearance.

The usefulness of a check-list is to provide a ready frame of reference on which to hang new data, to help to stabilize the nomenclatural and systematic treatment of the included forms in subsequent partial treatments or statements, and to give the non-ornithological systematist a quick tabulation of the diversity and distribution of the groups of animals covered. While there will always be differences of opinion between equally qualified specialists, the present volume seems to present a fairly well reasoned treatment, and it should be able to serve the various purposes outlined above. It also offers a hopeful sign that work on the remaining parts is in progress and that this compilation may be completed in the not too distant future.

The book is well printed, carefully proof read, and is provided with an adequate index.

HERBERT FRIEDMANN

DAS TIERREICH. *Eine Zusammenstellung und Kennzeichnung der rezenten Tierformen. Lieferung 76. Aves/Upupae. Bucerotidae.*

By Kurt Sanft. Walter de Gruyter & Co., Berlin. DM 78.- (paper). iv + 176 pp.; ill. 1960.

This is a careful, competent, and informative monograph of that interesting family of birds, the hornbills. The 45 species are assigned to 14 genera, 3 of which have not been recognized by some recent authors. The 106 illustrations are devoted to distribution spot maps of every species and to diagnostic drawings of sexual and racial differences. There are generic and species keys, complete synonymies, precise descriptions, lists of measurements and detailed data on life history and distribution, a bibliography, and an index. We owe the author thanks for this altogether admirable monograph, but none to the publisher who charges nearly $20.00 for a publication of 174 pages.

ERNST MAYR

PRIMATES. *Comparative Anatomy and Taxonomy. Part 3. Pithecoidea, Platyrrhini (Families Hapalidae and Callimiconidae).*

By W. C. Osman Hill. Edinburgh University Press, Edinburgh. 90s. xx + 354 pp. + 27 pl.; text ill. 1957.

This monograph is the third of a series designed to summarize existing knowledge of the structure, behavior, and classification of the Primates. The first two volumes, published in 1953 (*Q.R.B.*, 29: 387. 1954) and 1955 (*Q.R.B.*, 31:310. 1956) were concerned with the lemurs, loris, and tarsiers. The third is directed primarily towards the description of a family (Hapalidae) of New World monkeys (Platyrrhini). These, in the taxonomic scheme adopted by Hill, together with the Old World monkeys, apes, and man (Catarrhini), form the suborder Pithecoidea.

The first 76 pages of the present volume comprise a summary of the principal anatomical and taxonomic features of the Pithecoidea, while a further 39 pages are assigned to a corresponding analysis of the Platyrrhini. From this stage, attention is focused on the detailed taxonomy and characteristics of the marmosets and tamarins comprising the Hapalidae. As in earlier volumes, the data available in the literature are supplemented by the considerable original observations that Hill has been able to base on material from the London and other zoological gardens. The result is a compilation that gives to the student of primate morphology a working picture of the present stage of knowledge in this facet of the field. But the presentation of comparative material is always subject to considerable difficulties, and these are accentuated when, as in the present instance, there are big and irregularly distributed gaps in the available information. Consequently, as with its predecessors, the value of this monograph must, of necessity, vary according to the needs and interests of individual workers.

A significant paragraph is included in the introduction, and relates to the genus *Callimico*, a group assigned in the body of the monograph to a separate family: Callimiconidae. A specimen became available for dissection when it was too late for the results of its study to be incorporated in the text, and Hill notes that his view now is that "... *Callimico* is a tamarin, doubtless a primitive one, and that systematically it should form no more than a subfamily, Callimiconinae, of the Hapalidae."

E. H. ASHTON

ECONOMIC ZOOLOGY

NEMATOLOGY. *Fundamental and Recent Advances with Emphasis on Plant Parasitic and Soil Forms. Edited by J. N. Sasser and W. R. Jenkins. The University of North Carolina Press, Chapel Hill.* $12.50. xvi + 480 pp.; ill. 1960.

The nematodes that live in the soil and in the roots and stems of plants have received increasing attention, especially in the southern United States, in recent years. As their role in phytopathology has become more evident through losses in garden and field crops and in citrus fruits, various groups of investigators from universities, federal and state experiment stations, and other agricultural organizations have increased efforts to devise measures of control. The present volume was compiled from a series of lectures and laboratory exercises presented during a Southern Regional Graduate Summer Session in Nematology, held at North Carolina State College, June 8 to July 17, 1959. The project was sponsored by the Southern Regional Education Board and supported by the National Science Foundation. Advances of the past decade in the knowledge of the morphology, cytology, physiology, metabolism, genetics, reproduction, life history, bionomics, ecology, systematics, host-parasite relations, and technical procedures for the study of nematodes were discussed by 22 outstanding authorities of the United States, Canada, England, and Holland. The material is arranged in 9 parts, and consists of 47 articles, most of them with extensive bibliographies. Data are presented in large part in tabular form, and the text is illustrated with

abundant figures. The claim of the Foreword, that "this volume represents a milestone in the history of phytonematology in the southern region of the United States," is confirmed by inspection of the monograph.

HORACE W. STUNKARD

ADVANCES IN PEST CONTROL RESEARCH. *Volume III. Edited by R. L. Metcalf. Interscience Publishers, New York and London.* $14.50. viii + 448 pp.; ill. 1960.

The third volume in this series continues the excellence of monographic presentation established in the earlier volumes. Subjects covered are: the sterile male technique in insect control; synergism, antagonism and joint action in insecticides; the labeled pool technique and its applications in pesticides research; chemical attractants; organic halide nematocides; dithiocarbamate fungicides; DDT-dehydrochlorinase; triazine herbicides; and absorption and translocation of chemicals in plants. Although issued in 1960, some of the monographs include material only through 1958; thus the excellent review of the sterile male technique, written by R. C. Bushland, leaves the epoch-making eradication of the screw-worm from the southeastern states as an operation in progress rather than the present fait accompli. The authors are all well chosen—not only accomplished researchers in the fields under discussion, but skilled in summarizing and integrating the voluminous literature and in presenting the diverse data in a coherent manner easily absorbed by non-specialists. The completeness of the literature coverage is attested by the 1,330 references cited in the 9 articles. Where divergent views occur, all are presented and evaluated, e.g., P. S. Hewlett's assessment of the various concepts of synergism and its evaluation. The sections on attractants, organic halide nematocides, dithiocarbamate fungicides, and triazine herbicides provide thoroughgoing studies on the chemistry and mode of action in these specific groups and will be invaluable as reference material, but the greatest general interest will center in the chapters on the labeled poor technique and on absorption and translocation.

CARROLL N. SMITH

ANIMAL GROWTH AND DEVELOPMENT

ASEXUAL PROPAGATION AND REGENERATION. *By M. A. Vorontsova and L. D. Liosner; translated from the Russian by P. M. Allen. Pergamon Press, New York, London, Oxford, and Paris.* $12.00. xxiv + 489 pp.; ill. 1960.

This is a book in which comparisons are made between asexual reproduction throughout the animal kingdom, continuous replacement of parts, as in the case of blood and mucosa, regeneration of lost parts, and embryonic development. Many examples are cited and, fortunately for non-Russians, many of these are from the Russian literature, not yet well known outside the Soviet Union.

The book had its origin in a series of lectures delivered by Professor M. A. Vorontsova to students of the Biological Faculty of Moscow University. The material was expanded and modernized in collaboration with L. D. Liosner, another outstanding student of regeneration. It was translated from the Russian and produced by non-letterpress setting and photolithography. The method of production insured a lower cost and more rapid availability of important information.

There is a wide coverage of material, a fair amount of detail, and much thought leading to some general conclusions. The scope and level of the book can be illustrated by a few of the topics considered and the conclusions reached.

The authors disagree with the often-expressed belief that regenerative ability decreases with increasing complexity of organization. Instead, they believe that regenerative capacity should be considered a primary property of living substance. The problem of inducing regeneration where it does not occur becomes one of removing barriers, sometimes adaptive, that prevent the expression of this fundamental ability. The suggestion is made that limb regeneration may not occur in higher vertebrates because of adaptive changes associated with rapid healing of wound surfaces. The work of a number of Russian biologists has been unashamedly directed toward the practical goal of increasing the expression of latent regenerative ability in man. This work is continuing, but one can judge from the paucity of recent references that it is now proceeding more slowly. One suspects that studies in regeneration as well as studies of inheritance have been impeded by the resurrection of mid-nineteenth century hypotheses.

Mixed in with the reporting of carefully controlled and interpreted experiments are some purporting to be derived from tests of the hypothesis of the inheritance of acquired characters. This is a legitimate area of research, but these experiments probably have nothing to do with regeneration. One wonders if this is an expression of culturally enforced conformity satisfied by a change of labeling. It is to be hoped that this area of research, in which Russians have excelled in the past, will continue unimpeded.

Among other topics of general interest are cellular transformation during regeneration and regionally specific control of transformation by adult tissues.

This book should appeal not only to specialists in

regeneration, for whom it contains much information, but also to biologists in general who are interested in observing the development of a somewhat different biological culture.

S. MERYL ROSE

ANIMAL MORPHOLOGY

THE STRUCTURE OF THE EYE. *Proceedings of the Symposium held April 11–13, 1960, during the Seventh International Congress of Anatomists, New York, N. Y.*

Edited by George K. Smelser. Academic Press, New York and London. $15.00. xvi + 570 pp. + 33 pl.; text ill. 1961.

In this book are gathered not only the papers presented at this meeting but also the discussions on each paper. There are 35 papers by 50 authors. All parts of the eye are covered, including the retina, pigment epithelium, pecten, crystalline lens, vitreous body, endothelium of the anterior chamber angle, the trabecular meshwork, cornea, scleral stroma, iris, and ciliary epithelium. The retina is treated in the greatest detail, including the fine structure of the photoreceptors, location of various enzyme systems in the retina, relation of the pigment epithelium to the retina, and even some discussion of the electrophysiology of the retina in relation to its structure, although this is minimal. From the standpoint of the morphology and the fine structure of the eye, this book could hardly be surpassed as related to recent developments and research in this field. It is copiously illustrated with many fine electron micrographs. All the structures mentioned above are discussed, not only as they occur in normal eyes, but also in pathological conditions. A comparison of these two states has furnished many interesting ideas of the normal functioning of the retina and other parts of the eye. Not all of the articles will be of interest to any single visual physiologist or ocular anatomist; however, each reader will find several articles in his own particular field. It will be some time before another meeting is organized which will have new work of such high quality on this subject.

M. L. WOLBARSHT

THE MIDDLE EAR.

By Heinrich G. Kobrak; forward by John R. Lindsay; 6 contributors. The University of Chicago Press, Chicago. $15.00. xvi + 254 pp. + 6 pl.; text ill. 1959.

Kobrak, a recognized authority on the middle ear, was professor of otological research at the College of Medicine, Wayne State University, for a number of years prior to his death in 1957. He prepared this work for physicians in clinical practice who need to understand the detailed anatomy and physiology of the middle ear and some of the clinical and surgical considerations relating to the treatment of deafness resulting from middle ear pathology. The text is divided into two parts, the first of which was largely prepared by Kobrak and considers the structure, the stimulus (sound), the function, and the pathology of the middle ear. This section includes a chapter by Alvar Wilska, who has developed rather remarkable techniques for visualizing and measuring movements of the ear drum in response to sound. Also included is a chapter by J. E. Fournier on bone conduction testing. The second part of the book is on the surgical management of deafness resulting from pathological involvement of the sound conduction apparatus. The chapters in this part, in addition to the one by Kobrak on the use of acoustic prosthesis, were contributed by several outstanding surgeons: fenestration (John R. Lindsay), mobilization of the stapes (Samuel Rosen), tympanoplasty (H. Wullstein), and plastic surgery (Fritz Zoellner). The last-named discussed a series of procedures such as transmeatal occlusion plastic, meatantrotomy, attic antrotomy, etc. The text represents a most thorough general discussion of the middle ear and will probably serve for many years as a major reference work for otologists.

H. G. WAGNER

ANIMAL PHYSIOLOGY

MEDICAL PHYSIOLOGY AND BIOPHYSICS. *Eighteenth Edition of Howell's Textbook of Physiology.*

Edited by Theodore C. Ruch and John F. Fulton. W. B. Saunders Company, Philadelphia and London. $16.00. xxii + 1232 pp.; ill. 1960.

The first edition of the *Text-Book of Physiology for Medical Students and Physicians* appeared in 1905 and was written in its entirety by W. H. Howell, who continued to revise the book over the next 35 years. The 14th edition appeared in 1941. This was Howell's last edition and in it were many signs that he was failing to revise the text to conform with the latest experimental results. The 15th edition, in 1946 (*Q.R.B.*, 21:200. 1946), marked an abrupt change in editorial policy under the direction of J. F. Fulton, who headed a staff of no less than 24 authors. The book was up to date and became accepted as the standard textbook for physiology courses in those medical schools whose orientation was towards research. The present edition, the 18th, represents another major change in editorial

responsibility, and two-thirds of its 23 authors are new. The text has been thoroughly revised and in most fields is quite up to date. The material is generally presented in a clear and explicit fashion. However, the uncertainties which are connected with many of the theories are not neglected. Most of the technical and jargon terms are defined clearly, although the use of the term "jiffy" in place of "microsecond" seems unnecessary.

In spite of the multiplicity of authors little duplication of effort occurs, and most subjects are considered under their proper headings. However, the discussion on recording potentials in a volume conductor would be more useful if it were located in the section dealing with the cable and excitable properties of the cell membranes rather than in the section on special properties of nerve trunks and tracts. Until the most recent editions the unpopular Hering theory of color vision was explained in some detail in addition to the universally accepted Young-Holmholtz theory. It is ironical that now, just as the Hering theory is beginning to find powerful support from the neurophysiologists, the explanation of that theory is omitted.

The section on olfaction has the only serious omissions in the book. The statement is made that the olfactory receptor cannot be recorded from. Yet since 1956 Beidler and his colleagues have shown recordings made of impulses which originate in the olfactory receptor and travel along its axon in response to olfactory stimulation.

The above are minor criticisms, minor faults of an otherwise excellent book. Fortunate the medical student whose physiology course allows him to read and understand this book.

M. L. Wolbarsht

Haematology and Blood Groups. *Pap. Brit. Med. J., Vol. 15, No. 1 & 2, 1959.*

Edited by D. A. G. Galton and G. L. G. Goldsmith. The University of Chicago Press, Chicago. $4.00. vi + 169 pp. + 2 pl.; text ill. 1961.

This reprinting in book form of two issues of the *British Medical Bulletin* of more than a year ago makes a valuable addition to any library. It contains a series of 14 articles on Hematology and 15 on Blood Groups by leading English workers in these fields. In no sense is this material intended to be an exhaustive discussion or review of the whole field; instead, it represents the latest opinions on special subjects and offers, in concise form, the work, the ideas, and the mature judgment of experts on each subject. Any student or investigator in these special areas would do well to have this volume immediately available not only for ready reference but also for constant rereading of some of the important new studies presented. The book is a bargain both scientifically and monetarily.

Louis K. Diamond

Mineral Metabolism. *An Advanced Treatise. Volume 1. Principles, Processes, and Systems. Part A.*

Edited by C. L. Comar and Felix Bronner. Academic Press, New York and London. $12.00. xvi + 424 pp.; ill. 1960.

It is extraordinarily difficult to evaluate a book of this sort. The subtitle, *An Advanced Treatise*, suggests that the treatment of the material is to be extensive and rigorous, while the fact that the chapters are written by a large number of experts makes it certain that the level of discussion will be uneven. Perhaps the best approach that a reviewer can make is to list the chapters and then comment briefly on some of them. These are: Homeostasis in mineral metabolism (F. C. McLean); Thermodynamic principles and concepts (J. B. Best and J. Z. Hearon); Cybernetic aspects of Homeostasis (S. Goldman); Chelation (T. Moeller and E. P. Horwitz); Compartmental methods of kinetic analysis (A. K. Solomon); Ion transport (V. Koefoed-Johnsen and H. H. Ussing); Body fluid dynamics (J. R. Robinson); Intestinal absorption and excretion (E. Y. Berger); Renal excretory mechanisms (M. Walser and G. H. Mudge); and Extrarenal regulations (I. L. Swartz). Volume I, part B, is to follow and will consider hormonal control of mineral metabolism, bone and connective tissue mineral metabolism, and interrelationships with enzymes.

The chapter on thermodynamics is a fine condensation of much relevant material of both classical and irreversible sorts. It does not consider the practical working equations that are usually used in analyzing flux data, and indeed the absence of such a chapter would appear to be a serious lack in the book. The chapter on cybernetics is difficult to relate to the subject matter at hand; one has the feeling that it would be better omitted in favor of more relevant material. Similar remarks apply to the chapter on chelation. The chapters on compartments and ion transport are of very high quality and deal with material most pertinent to the book. The chapter on body fluid dynamics is a most refreshing one, and the treatment is clear and in many cases novel.

L. J. Mullins

BIOCHEMISTRY

Photochemistry *in the Liquid and Solid States. Based on Some of the Papers Presented at a Sym-*

posium held at Endicott House in Dedham, Mass., September 3–7, 1957. Arranged by The Sub-Committee of the National Academy of Sciences—National Research Council and Supported by the National Science Foundation.

Edited by Farrington Daniels. John Wiley & Sons, New York and London. $6.00. vi + 174 pp.; ill. 1960.

This symposium was held to determine the state of knowledge at the time concerning the photochemical storage of energy. A few of the papers are concerned with the practical or technical side of the problem, but most of them are reports of basic research on photochemical processes. In addition to an interesting introduction outlining the problem of the storage of solar energy, the following chapters are represented: Photochemical reactions; Photosensitized reactions; Fluorescence; Kinetic considerations; Role of the triple state; Photochemical reactions involving chlorophyll; and Photoreactions in solids. Some of the papers were published in the January, 1959, issue of *The Journal of Physical Chemistry*. It is unfortunate that, since the date of the symposium, almost three years have elapsed before this official report appeared.

EMIL H. WHITE

ORGANIC REACTIONS. *Volume 11.*

Editor-in-Chief: Arthur C. Cope. John Wiley & Sons, New York and London. $12.00. viii + 501 pp. 1960.

Volume XI is the latest in this series of comprehensive surveys of organic reactions. The chapter headings for this volume are: The Beckmann rearrangement; the Demjanov and Tiffeneau-Demjanov ring expansions; Arylation of unsaturated compounds by diazonium salts; The Favorskii rearrangement of haloketones; and olefins from amines: the Hofmann elimination reaction and amine oxide pyrolysis. Each chapter contains a discussion of the mechanism of the reaction, experimental procedures, and exhaustive tables of data which serve to outline the scope of the reaction.

EMIL H. WHITE

HETEROCYCLIC CHEMISTRY.

By Alan R. Katritzky and Jeanne M. Lagowski; foreword by Sir Alexander Todd. John Wiley & Sons, New York; Methuen & Co., London. $4.75. 274 pp. 1960.

This extremely tersely written volume on heterocyclic compounds is intended for readers with some background in organic chemistry. The coverage is remarkable for a book of its size, and the index reflects this coverage; 37 different headings appear under *THIAZOLE*, for example. The text is very well illustrated, and as a useful feature, the hundreds of formulae (nearly 2500 according to the publisher) are numbered with Arabic numerals. The text includes, in addition to a general introduction to the study of heterocyclic compounds, synthetic methods, typical reactions, and some reaction mechanisms. *Heterocyclic Compounds* can be recommended as an introduction to this field of chemistry and also as a one-volume reference for heterocyclic compounds.

EMIL H. WHITE

COMPARATIVE BIOCHEMISTRY. *A Comprehensive Treatise. Volume I. Sources of Free Energy. Volume II. Free Energy and Biological Function.*

Edited by Marcel Florkin and Howard S. Mason. Academic Press, New York and London. (Vol. I) $18.00; (Vol. II) $20.00. (Vol. I) xxvi + 590 pp.; ill.; (Vol. II) xx + 685 pp. + 9 pl.; text ill. 1960.

Comparative biochemistry is a recent approach to the study of biology. It has developed from roots in organic and physical chemistry as well as in the biological sciences. Its domain is vast because it compares the physicochemical properties of every form of life and finds that biological diversity is as interesting as biological unity. Comparative biochemistry seeks differences and similarities in those reaction systems upon which biological form and function ultimately depend. In this sense it includes all of biochemistry.

This comprehensive treatise on comparative biochemistry is organized in the following manner: Volumes I and II are primarily concerned with the biological transformations of free energy. Volume I deals with the sources of biologically useful free energy, while Volume II describes how this free energy is utilized to support function. Other subjects of comparative biochemistry are to appear in subsequent volumes. According to the editors, Volumes III and IV will include the structures of the principal classes of metabolites, their distribution, and the comparative enzymology of their biogenesis and metabolism. Volumes V and VI will deal with the comparative biochemistry of organized reaction systems and the biological functions dependent upon these systems.

Since transformations of energy from one form to another are discussed in the first two volumes, it is fitting to have at the beginning of Volume I a chapter on the Thermodynamics of Living Systems (H. Eyring, R. P. Boyce, and J. D. Spikes) in order to establish the basic background necessary for an understanding of the thermodynamics or energy relations of biological systems. Biophysical and biochemical responses to light and thermal energy are described in chapters on Phototropism and Phototaxis (K. V. Thimann and G. M. Curry),

The Distribution and Evolution of Visual Systems (G. Wald), and the Utilization of Thermal Energy by Living Organisms (M. B. Allen). Biochemical processes which produce free energy from inorganic substances are the subject of a chapter by C. Fromageot and J. C. Senez. The comparative aspects of the energy-furnishing and energy-conserving metabolic reactions of glycolysis, fatty acid oxidation, and electron transport are discussed by E. Bueding and E. Farber, P. K. Stumpf and G. A. Barber, and E. E. Conn, respectively. The biological significance of onium compounds and of phosphoric acid anhydrides and other energy-rich compounds, described by G. L. Cantoni and by F. M. Huennekens and H. R. Whitely, respectively, complete the contents of Volume I. Although all these contributions fit extremely well within the organizational plan of the editors, the rationale for their order within the volume seems obscure. For instance, the chapter on fatty acid oxidation immediately follows the section on thermodynamics, whereas the discussion of glycolysis and the utilization of thermal energy are at the end of the book.

Volume II deals with the utilization of free energy in biology. The first 4 chapters are concerned with the biosynthesis of phosphates, of saccharides, of peptides and proteins, and with ammonia metabolism and urea formation. They are written by M. R. Atkinson and R. K. Mortin, by L. F. Leloir, C. E. Cardini and E. Cabib, by H. Chantrenne, and by P. P. Cohen and G. W. Brown, Jr., respectively. The other important processes requiring energy which are included in this volume are: Muscular contraction (S. V. Perry), Other mechanisms producing movements (H. Hoffman-Berling), Active transport (B. Andersen and H. H. Ussing), Balance of water, electrolytes and non-electrolytes (F. Brown and W. D. Stein), Osmoregulation (J. Shaw), Nerve conduction and electrical discharge (M. A. Gerebtzoff and E. Schoffeniels), and Bioluminescence (E. Newton Harvey).

The editors have stated that the aim of this treatise is to provide a sound, critical, and provocative summary of present knowledge in the field. Volumes I and II suggest that the successful attainment of their objective is well under way, and we look forward to the remaining volumes of this series.

BERTRAM SACKTOR

LECTURES ON HAEMATOLOGY. *Thirteen Lectures Delivered in Cambridge at a Course for Physicians and Clinical Pathologists.*

Edited by F. G. J. Hayhoe. Cambridge University Press, New York and London. $11.50. x + 247 pp. + 11 pl.; text ill. 1960.

This book is not meant to be either a textbook or a reference book, and anyone who wants a complete discussion of the various subjects included here will be disappointed. However, the volume is definitely enjoyable and interesting reading. Several of the lectures, as for example that on Transfusion Hazards, are more philosophical than strictly scientific discussions of the subject and, since written in an easy, conversational style, in contrast to the stilted and usually cumbersome scientific language of the average medical article, the reader can relax and enjoy himself. It should be emphasized that many of the articles offer the latest expert opinion on hematologic subjects, with data often presented in original fashion by the expert who was chosen because of his pioneer work in the field.

The book in no way attempts to cover all blood diseases nor every phase of each one. Nevertheless, there is a great deal of information packed in this small volume. Anyone interested in hematology will benefit from these review lectures.

LOUIS K. DIAMOND

THE ENZYMES. *Volume 2: Purine and Pyrimidine Nucleotides and Phosphagens. Prosthetic Groups and Cofactors, (Part A). Second Edition.*

Edited by Paul D. Boyer, Henry Lardy, and Karl Myrbäck. Academic Press, New York and London. $16.00 vix + 479 pp.; ill. 1960.

THE ENZYMES. *Volume 3: Prosthetic Groups and Cofactors (Part B). Second Edition.*

Edited by Paul D. Boyer, Henry Lardy, and Karl Myrbäck. Academic Press, New York and London. $16.00. xiv + 497 pp.; ill. 1960.

Enzymology is regarded as a subdivision of biochemistry; but the child of yesterday has engulfed the parent. This new edition of the treatise *The Enzymes* includes a large proportion of that information which is either indispensible for all biochemists, or interesting to all because of its relatively recent origin. Volumes 2 and 3 of this series were originally intended to be one volume, which was split into two because of its excessive size. After the general treatment of kinetics and mechanism in Volume 1 (*Q.R.B.*, 35:164. 1960), the reader is invited to view the particulars of prosthetic group and cofactor chemistry. Volume 2 includes separate chapters on the nucleotides of adenine (R. M. Bock), of uracil (L. F. Leloir and C. E. Cardini), of cytosine (E. P. Kennedy), and of guanine and hypoxanthine (M. F. Utter), with a separate chapter on N-phosphorylated guanidines (J. F. Morrison and A. H. Ennor). The section of Prosthetic Groups and Cofactors (Part A) includes chapters on pyridoxal (A. E. Braunstein), folic acid (J. C. Rabinowitz), glutathione (W. E. Knox), thiamin (D. E. Metzler), and flavins (H. Beinert). Part B of this section makes

up Volume 3 of the series and includes chapters on coenzyme A (L. Jaenicke and F. Lynen), the pyridine coenzymes (N. O. Kaplan), charge-transfer complexing of pyridinium rings (E. M. Kosower), lipoic acid (L. J. Reed), metals (B. L. Vallee), heme (K. G. Paul), vitamin K (H. Dam and E. Sondergaard), and vitamin E (P. D. Boyer). The three concluding chapters of Volume 3 include a stimulating essay on enzymic aspects of the visual process (G. Wald and R. Hubbard), a chapter on the function and metabolism of ascorbic acid (J. J. Burns and G. Ashwell), and a chapter on Enzymic Equilibria and Thermodynamics (M. J. Johnson). This last chapter was originally intended for inclusion in Volume 1, where its contents might seem more at home. We would be happy to see it anywhere. Written for the average biochemist rather than the specialist, it is clear, succinct, and eminently useful.

As in the case of Volume 1, each chapter is written by an expert who is currently contributing to the rapid development which characterizes almost all areas and aspects of enzymology. The list of contributors almost constitutes a "Who's Who in Enzymology." Though English is used throughout, an effort has been made to be international in the selection of authors. The editors are to be congratulated on their good judgment and on the not inconsiderable effort which must have been required to maintain the high quality of the first volume. The second edition of *The Enzymes* is an indispensible reference work for the active research enzymologist.

BIRGIT VENNESLAND

ADVANCES IN ENZYMOLOGY *and Related Subjects of Biochemistry. Volume XXII.*
Edited by F. F. Nord. Interscience Publishers, New York and London. $14.00. vi + 567 pp.; ill. 1960.

This volume is the latest issue of one of the oldest of the annual review series, now so ubiquitous. It contains reviews of 9 topics ranging from highly chemical to more biological phases of enzymology. The more chemical chapters are those on the laboratory synthesis of nucleotide coenzymes (J. Baddiley and N. A. Hughes) and the synthesis and hydrolysis of sulfate esters (A. B. Roy). Two chapters are concerned largely with the biosynthesis of natural products, cholesterol (G. Popjak and J. W. Cornforth) and sulfonium compounds (S. K. Shapiro and F. Schlenk). Others cover column chromatography of enzymes (F. Turba), coenzyme binding (S. Shifrin and N. O. Kaplan), and active sites and enzyme action (D. E. Kosland). Finally, two contributions reflect the very explosive growth of genetic aspects of biochemistry and review the genetic control of enzyme activity (J. R. S. Fincham) and induced enzyme synthesis (H. O. Halvorson).

Each chapter is directed largely toward readers who have had some previous exposure to the subject. In general, these reviews serve well for such people when they wish to bring their knowledge up to date, particularly for pedagogical purposes.

I. M. KLOTZ

THE NUCLEIC ACIDS. *Volume III.*
Edited by Erwin Chargaff and J. N. Davidson. Academic Press, New York and London. $18.00. xvi + 588 pp.; ill. 1960.

This volume is an outstanding contribution to the literature on nucleic acids. The 12 articles include: Deoxyribonucleic acids as macromolecules (C. L. Sadron); Photochemistry of nucleic acids and their constituents (D. Shugar); Chemical and enzymic synthesis of polynucleotides (H. Gobind Khorana); Chemistry of the nucleic acids of microorganisms (A. H. Belozersky and A. S. Spirin); The nucleic acids of the bacterial viruses (Robert L. Sinsheimer); The ribonucleic acids of viruses (Heinz Shuster); Biosynthesis of purine nucleotides (John M. Buchanan); Biosynthesis of pyrimidine nucleotides (George W. Crosbie); The relationship of nucleic acid and protein synthesis as revealed by studies in cell-free systems (Mahlon B. Hoagland); Biosynthesis of proteins in intact bacterial cells (F. Gros); Agents which influence nucleic acid metabolism (R. E. Handshumacher and A. D. Welch); and The effect of radiations on nucleic acid metabolism (L. G. Lajtha). Each article, written by an expert in the respective area, is presented well and, in keeping with the two earlier volumes, is well documented with reference to the original literature.

Sadron presents an excellent review of the experimental procedures for determining the molecular weight, shape, and dimensions of nucleic acids, and uniquely stresses the shortcomings of the available methods. Shugar starts with first principles in photochemistry, and discusses ultraviolet irradiation of small molecular weight compounds, hyperchromic effects, irradiation of viruses, and finally photoreactivation phenomena. The article by Belozersky and Spirin is particularly useful since it presents a compilation of base-ratios for a multitude of bacteria, protozoa, fungi, and algae which complement the data presented in Volume I by Chargaff. Sinsheimer's article on nucleic acids in bacterial viruses is unusually complete, and includes aspects of the biochemistry of phage infection as well as the physical chemistry of phage DNA and a discussion of the replication process. It is interesting to note that a series devoted exclusively to nucleic acids contains an article on the biosynthesis of proteins in the intact bacterial cell (F. Gros), but it is obvious that a discussion of either subject must include the other.

The uniform excellence of the contributions to this volume is gratifying.

MAURICE J. BESSMAN

METHODS OF BIOCHEMICAL ANALYSIS. *Volume VIII. Edited by David Glick. Interscience Publishers, New York and London.* $10.00. x + 400 pp.; ill. 1960.

This review volume places emphasis on methodology and instrumentation concerning the following 8 topics of current importance: Qualitative and Quantitative Determination of the Fatty Acids by Gas-Liquid Chromatography (A. T. James); The Measurement of Luciferin and Luciferase (Aurin M. Chase); Enzymic Analysis of Steroid Hormones (Paul Talalay); Aliphatic Ammonium Salts in the Assay of Acidic Polysaccharides from Tissues (J. E. Scott); Isolation and Determination of Neuraminic (Sialic) Acids (M. W. Whitehouse and F. Zilliken); Determination of Porphyrins in Biological Materials (Samuel Schwartz, Marie H. Berg, Irene Bossenmaier, and Howard Dinsmore); *In vitro* Frog Skin Assay for Agents that Darken and Lighten Melanocytes (Aaron B. Lerner and M. Ruth Wright); and Principle and Method of Heatburst Microcalorimetry and the Determination of Free Energy, Enthalpy and Entropy Changes (Charlotte Kitzinger and T. H. Benzinger). All chapters are accompanied by extensive references and the book includes an author and subject index as well as a cumulative author-subject index to Volumes I–VIII.

The general plan followed in the organization of the individual chapters is a discussion of the background and previous work, a critical evaluation of the various approaches, and a presentation of the procedural details of the methods preferred by the author. As usual, this is an invaluable series of reviews which added to the previous volumes "comprise a self-modernizing encyclopedia of methods of biochemical analysis." This quoted purpose of the Advisory Board, expressed in the Preface to the Series, is indeed being fulfilled.

EUGENE W. RICE

STANDARD METHODS OF CLINICAL CHEMISTRY. *Volume 3.*

By the American Association of Clinical Chemists; David Seligson, editor. Academic Press, New York and London. $6.50. x + 230 pp.; ill. 1961.

This volume is appropriately dedicated to the memory of John Punnett Peters (1887–1955) "who made great contributions in clinical chemistry, and in his applications of clinical chemistry made major contributions to clinical research and clinical medicine." Analytical methods are presented for 20 biological constituents and the respective chapters on them are entitled: Alcohol in Biological Materials, Aldolase, Arsenic in Biological Materials, Ascorbic Acid in Blood and Urine, Barbiturate, Assay of Catechol Amines in Urine by Means of a Strip of Rabbit Aorta, Catechol Amines in Urine, Chloride (Cotlove "Chloridimeter"), Cholinesterase in Human Red Blood Cells and Plasma, Creatinine and Creatine in Urine and Serum, Fibrinogen, Gastric Acidity, Hemoglobins, Hydrocortisone in Plasma, Lactic Acid, Mercury in Urine, Phosphohexose Isomerase, Salicylate, Sulfonamides, and Transaminase. The policy of having each method checked by an independent investigator, a policy established with Volume 1, has been continued. In general, the lists of references are adequate, although the number of references cited ranges widely—from only 4 on "Salicylate" to 122 on "Hemoglobins." There are author and subject indexes.

Volume 3 continues to provide accurate and workable methods upon which the analyst can rely. An ideal analytical method is specific and accurate, rapid, simple, and economical. No single method is ideal, and analytical procedures are continually evolving toward these goals. Hence, these manuals will require periodic and frequent revision in order to reflect the advances in analytical biochemistry. In this respect, at least, the use of the word "Standard" in the title of this essential series is a misnomer and possibly should be discontinued.

EUGENE W. RICE

MICROBIOLOGY

MILESTONES IN MICROBIOLOGY.

Translated and edited by Thomas D. Brock. Prentice-Hall, Englewood Cliffs. $3.95. xii + 275 pp.; ill. 1961.

Thomas D. Brock states, in the Preface to his book, that "this is not a history of microbiology. This collection of articles supplements the work done by undergraduate students in their first year of microbiology. It is further intended to be an interesting and useful reference for advanced students and practicing microbiologists." Through either modesty or neglect, neither editor nor publisher mentioned that this book constitutes one of the most engagingly provocative volumes on microbiology for the layman since de Kruif's *Microbe Hunters* appeared in 1926 (*Q.R.B.*, 1:313. 1926). Aside from the foregoing omission, the objectives are sound. Many students can be taught the fundamentals of experimental design in microbiology by reading assigned papers in various areas. Brock has selected articles by the originators of microbial theory and methodology for this purpose and made them available in translated and abridged form. Current papers rarely surpass,

in simplicity of language and significance of discovery, the examples set forth by Leeuwenhoek, Pasteur, Koch, and other founders of this science. A brief commentary follows each paper. This commentary facilitates an understanding of the problems encountered, the approaches taken, and the significance of the results obtained. The student cannot avoid gaining at least a partial knowledge of the history of microbiology and an appreciation for this science as byproducts of the primary objective. In like manner, the layman and the practicing microbiologist will find this volume stimulating, not necessarily from the aspect of improving research approaches, but because the book is very entertaining.

A Historical Introduction precedes 55 articles in 6 areas of microbiology: Spontaneous Generation and Fermentation (16 papers), The Germ Theory of Disease (11), Immunology (7), Virology (4), Chemotherapy (5), and General Microbiology (12). The original French texts of 5 of the papers are provided in an Appendix. A span of almost 400 years is encompassed by the articles, the earliest paper being a report by Girolamo Fracastoro in 1546 (Contagion, contagious diseases, and their treatment), and the latest paper being an announcement by Donald D. Woods (The relation of para-aminobenzoic acid to the mechanism of the action of sulfanilamide), published in 1940. Major emphases are on the discoveries of the 1800's (38 articles), while the 1500's, 1600's, 1700's, and the 1900's are represented by 1, 2, 3, and 11 articles, respectively. No papers on microbial genetics are included because this area "has not yet reached the stage where it can be presented intelligibly to undergraudates through isolated articles," and there are already two collections containing most of the significant works in it. This omission leaves the volume in a position somewhat analogous to that of a TV Western minus the Indians; sometimes the Indians are not called for in the script, but their presence often makes the show more interesting. Works on fungi, protozoa, or algae have also been omitted, probably because the scope of this volume had to be so delineated as to keep the size of the book within reasonable limits, and because somewhat different experimental approaches were basic to developments within these areas. Regardless of these limitations, the book contains extremely interesting "short stories," the best works of the all-time all-star authors of microbiology.

PAUL A. HARTMAN

ANNUAL REVIEW OF MICROBIOLOGY. *Volume 14. Edited by Charles E. Clifton; associate editors, Sidney Raffel and Mortimer P. Starr. Annual Reviews, Palo Alto.* $7.00. viii + 391 pp.; ill. 1960.

The fourteenth annual volume of this perennial series contains 17 articles whose titles reveal the breadth of contemporary microbiology. Their style and approach vary considerably, and those which are concerned with a particular aspect of a topic are far more rewarding than those in which the author spreads irregularly over the subject. In the former, the result is a more substantial picture of the topic irrespective of any familiarity with it, while in the latter, one seems to be reading a catalog. The first approach is exemplified in the articles Intramural spread of bacteria and viruses in human populations (R. E. O. Williams), Protein syntheses in microorganisms (G. D. Novelli), *In vitro* cell-virus relationships resulting in cell death (D. L. Walker), Synchronous division of microorganisms (O. H. Scherbaum), Gene action (C. Yanofsky and P. St. Lawrence), Immunological speculations (N. K. Jerne), and Interpretation of immunodiffusion tests (A. J. Crowle). The last-named author has written an extremely timely article about a technique which is rapidly finding new uses in the biological sciences.

MICHAEL CARSIOTIS

A GUIDE TO THE IDENTIFICATION OF THE GENERA OF BACTERIA *with Methods and Digests of Generic Characteristics. Based on Data given in the Seventh Edition of Bergey's Manual of Determinative Bacteriology and on Original Papers.*

By V. B. D. Skerman. The Williams & Wilkins Company, Baltimore. $5.50 (paper). x + 217 pp. + 31 pl.; text ill. 1959.

This is a compact reference handbook to be used for the systematic identification of bacteria at the level of the genus, as a companion volume to the familiar *Bergey's Manual of Determinative Bacteriology*. It is arranged in 4 major subdivisions: (1) A Comprehensive Key to Genera; (2) A Digest of Genera; (3) Methods; and (4) A Guide to Study.

The first section is a somewhat expanded Key to Genera and was originally prepared by the author for *Bergey's Manual*. It provides a systematic process of elimination to be used for the identification of the genus of an unknown organism. In the second section, the Digest, a brief, yet comprehensive, summary description of each genus is given, with emphasis placed on the characteristics that differentiate various species. The information embodied in the work is based not only on that in the 7th edition of *Bergey's Manual* (*Q.R.B.*, 33:94. 1958) but also on more recently published research papers. These first two sections (one is really a mirror image of the other) should make this book particularly useful to research or diagnostic bacteriologists confronted with an unfamiliar organism. It is the logical preliminary reference work to consult before using *"Bergey,"* where the emphasis is on the task of differentiating species.

The third section of the *Guide* is a compendium of all the basic methods necessary to characterize or identify bacteria according to the outline set forth in the Key of the first section. In addition to the analytical methods familiar to the classical bacteriologist, this section includes also the use of special selective media for isolating specific genera of bacteria for purposes of taxonomy, diagnosis, or application to some special problem. Sections two to four, an outline guide to taxonomy, are included especially to aid the student or novice bacteriologist.

This work is no mere compilation of bacteriological information. What the author has very modestly entitled a *Guide* is actually a self-sufficient, analytical compendium of genera and a laboratory manual for the bacteriologist. The author has indeed fulfilled his intention, that "of placing in the hands of research workers, teachers, and students, a volume in which general directives for the identification of bacteria are supported by a complete list of the techniques needed for the purpose."

C. DeLuca

PAPERS ON BACTERIAL VIRUSES.

Selected by Gunther S. Stent. Little, Brown & Company, Boston and Toronto. $4.60 (paper). xxx + 521 pp.; ill. 1960.

The volume begins with an introduction by Stent which is actually a 14-page review of our knowledge of bacteriophage—a veritable tour de force. The remainder of the book consists of reproductions of 25 original publications in the field of bacterial viruses. All of the papers presented are important contributions. They range from selections from a symposium on bacteriophage held in 1922 in which the views of D'Herelle, Twort, and Bordet are expressed, to the recent studies on new enzymes formed in bacteria after phage infection by Kornberg and his associates. (Papers originally in French or German are presented in translation.)

There is a definite need for books of this type—and not in the bacterial virus field only. Such a collection should be invaluable to workers in the field who entered it too late to obtain reprints of many of these papers. It should also be very useful as a textbook or supplementary textbook for advanced courses in the subject, where it is desired to expose the student to the original literature in the field. The only unpleasant feature is that the book, although a paperback, costs $4.60.

R. S. Edgar

FUNDAMENTAL PRINCIPLES OF BACTERIOLOGY. *Fifth Edition.*

By A. J. Salle. McGraw-Hill Book Company, New York, Toronto, and London. $11.00. x + 812 pp.; ill. 1961.

One of the more popular textbooks in general bacteriology has been revised to incorporate scientific advancements since publication of the fourth edition in 1954 (*Q.R.B.*, 29:397. 1954). The many developments which have occurred in microbiology during this interim are exemplified by the inclusion, in the fifth edition, of an excellent (21-page) chapter on Bacterial Genetics, by W. R. Romig. C. E. ZoBell has revised his chapter on the Bacteriology of the Sea, taxonomy has been modified to conform with the seventh edition of *Bergey's Manual*, some illustrations have been replaced with better ones, and additional photographs have been added. Many other major and minor modifications have been made; in fact, all chapters have been revised, more or less. The reader is assured of current knowledge, expressed in modern terms, as well as a mode of presentation which has proven successful for 22 years.

The professor who has used the fourth edition will find that the format and sequence of chapters follow the same outline as previously, but that his lecture notes will need extensive revision (if such has not been already done). A fifth edition of Salle's laboratory manual, *Fundamental Principles of Bacteriology* (201 pp., $3.50, McGraw-Hill) is available to accompany the text. The student with a background in organic chemistry will find that the text is comprehensive, yet simple in presentation. Sufficient material is covered so that the text could also be used where courses in both general and advanced general bacteriology are offered. Numerous references are included following each chapter. These will be of much help to the more advanced student and to others who wish to become thoroughly acquainted with specific areas within the science of microbiology. However, a more judicious selection of references might be more appropriate for use in a course in general bacteriology.

Periods of 4, 5, 6, and 7 years have elapsed between the successive editions of this book. Extrapolating on the basis of this past trend, one would not expect to see the next revision for 8 more years, in 1969. Bookstore managers and students who might wish to offer their texts for resale will appreciate this point.

Paul A. Hartman

HEALTH AND DISEASE

ATTENUATED INFECTION. *The Germ Theory in Contemporary Perspective.*

By Harold J. Simon; forewords by René J. Dubos

and Walsh McDermott. J. B. Lippincott Company, Philadelphia and Montreal. $10.00. xvi + 349 pp.; ill. 1960.

Simon has prepared an informative monograph that should stimulate interest and investigations which may better characterize the factors influencing symbiosis, infection, and disease attributed to microorganisms invading animals and man. The importance of factors of virulence and host resistance, in determining whether or not disease results from the relationship between the host and microorganisms, is clearly indicated in this monograph. Furthermore, Simon has defined the types of parasites and the various mechanisms of host resistance which may be of significance in influencing the development of attenuated infection. Beyond this, he has presented information on the influence of one organism upon another in the course of infection, as, for example, in viral interference and changes in "normal flora." The usefulness of tissue cultures for studying attenuation of infection has been given a special place in the monograph. Besides a discussion of the fundamental mechanisms, the author has presented a chapter on the clinical features of attenuated infections in man, and some of the environmental, chemotherapeutic, and metabolic factors which have influenced the changing importance of such infections in human beings. This book will be of great value to all interested in infection, microbiology, immunology, ecology, epidemiology, and public health aspects of microbial disease.

LEIGHTON E. CLUFF

EVALUATION OF DRUG THERAPY. *Proceedings of the Symposium on Evaluation of Drug Therapy in Neurologic and Sensory Diseases held at the University of Wisconsin, May, 1960.*

Edited by Francis M. Forster. The University of Wisconsin Press, Madison. $4.00. xxiv + 167 pp. 1961.

The major portion of this symposium consists of papers related to the broad problems of drug testing applicable to all medical fields. The final section consists of 8 panel reports giving broad definitions of various areas of neurologic diseases: epilepsy, parkinsonism and diseases of the basal ganglia, diseases of the muscles, glaucoma, headache, multiple sclerosis, neuropathies and neuralgias, and vertigo.

Two reviews are outstanding, namely, James E. P. Toman's on Pharmacologic problems in evolving new drugs in the field of neurologic and sensory diseases and Shirley H. Ferebee's On evaluating the results of a clinical trial: controls in search of a study. The former provides a classical description of preclinical pharmacology with its chemical, biological, medical, toxicological, and yes, even political aspects. The latter supplies a sagacious overview of the many difficulties of cooperative clinical trials of new drugs, problems of criteria of medical diagnosis, improvement, treatment and cure, and experimental bias. The accumulated years of wisdom of thirteen controlled trials in tuberculosis chemotherapy are included in Ferebee's review. The ever-growing number of research people conducting or planning controlled clinical trials will be able to read this book with profit.

C. JELLEFF CARR

PSYCHOLOGY AND ANIMAL BEHAVIOR

ANNUAL REVIEW OF PSYCHOLOGY. *Volume 11. Paul R. Farnsworth, editor; Quinn McNemar, asso. ed. Annual Reviews, Palo Alto.* $7.00. x + 544 pp. 1960.

ANNUAL REVIEW OF PSYCHOLOGY. *Volume 12. Paul R. Farnsworth, editor; asso. eds., Olga McNemar and Quinn McNemar. Annual Reviews, Palo Alto.* $7.00. x + 533 pp. 1961.

The 1958 editorial committee of the *Annual Reviews of Psychology* has set up a plan that will make future issues reflect more fully the increasing specialization of individual psychologists, increasing diversification of the activities of psychologists as a group, and greatly increased total output in the form of journals and books. This plan, subject to annual scrutiny and revision, is presented in a preface to the 1960 edition. It includes a systematic breakdown of the major areas of psychology into subareas, each of which is to be treated less frequently than the major areas had been in earlier editions. Thus for the yearly chapter on Vision are substituted chapters on Color Vision, Spatial Vision, and Visual Sensitivity, each of which is to appear triennially. For the yearly chapter on Physiological Psychology is substituted a biennial chapter on Brain Functions, chapters on Electrophysiology and Behavior and on Psychopharmacology, each of which is to appear at four year intervals, and chapters on the Neurophysiology of Learning and on the Psychophysiology of Emotion, each of which is to appear at three year intervals. A yearly chapter will be devoted to Audition; Perception and the Chemical Senses will each be reviewed every two years, etc.

Of special note to workers in the biological sciences are a Review of Theory in Physiological Psychology (L. H. Pribram); Behavior Genetics (J. L. Fuller); Color Vision (L. A. Hurvich and D. Jameson); Psychological Aspects of Aging (J. E. Birren); and Psychopharmacology (S. Ross and J. O. Cole) which appear in the 1960 edition, and Comparative

Psychology (W. H. Thorpe); Brain Functions (K. L. Chow); Visual Sensitivity (C. G. Mueller); Hearing (I. Pollock); and Chemical Senses (L. M. Beidler) which appear in the 1961 edition.

It seems worthwhile to single out one chapter for special note in order to raise the question of what is appropriate in an annual review. While Pribram's chapter is a truly excellent and interesting one, the fact that 54 of its 154 references are to works dated prior to 1954 marks a strong departure from the view expressed by the editorial committee of the first volume of the series who "... deemed it desirable to specify that reviews cover principally publications during the previous year which the authors considered most noteworthy." Many outlets in the form of books, symposia, handbooks, journals with review articles, etc. are available for overviews such as Pribram's, and indeed he has made numerous noteworthy contributions through such outlets. Except for the Abstracts, however, which themselves are several years behind recent work and provide no organizational or evaluative help, no sources are available to which the worker may go for an authoritative, coherent, comprehensive, evaluative, annotated, up-to-date bibliography of work in his own or other fields. One wonders if the original service of the Annual Reviews should be neglected even when so fine a work as Pribram's is offered as a substitute.

LEONARD MATIN

THE ARCHETYPES AND THE COLLECTIVE UNCONSCIOUS. *Bollingen Series XX. The Collected Works of C. G. Jung. Volume 9, Part I.*

By C. G. Jung; translated by R. F. C. Hull. Pantheon Books, New York. $7.50. xii + 462 pp.; ill. 1959.

AION. *Researches into the Phenomenology of the Self. Bollingen Series XX. The Collected Works of C. G. Jung, Volume 9, Part II.*

By C. G. Jung; translated by R. F. C. Hull. Pantheon Books, New York. $4.50. xii + 344 pp. + 3 pl.; text ill. 1959.

In a foreword written for Erich Neumann's *The Origins and History of Consciousness* (*Q.R.B.*, 30: 319. 1955), Jung spoke in admiration of the author for doing that which he would do himself were he "granted a second lease of life," namely, to put together the fragments resulting from his pioneering efforts in the discovery and description of the collective unconscious, and to make of them a coherent account of the natural evolution of consciousness.

In the two volumes under review, Jung's original works have been republished, but also on occasion reworked and added to, and in the second part new material is presented. This should be digested before reading Neumann.

As the title of Part I states, the volume has to do with the evidence for an impersonal, universal unconscious, heriditarily determined as the psychic expression of the instincts. As such, it has to do with preconscious psychic experience, and the contents therefore are not personal, and not material repressed from consciousness. As Jung says, there were psychic processes and functions long before any ego-consciousness existed. "Thinking existed long before man was able to say: 'I am conscious of thinking'" (Vol. 9, Pt. I, p. 280).

The symbols of such preconscious thinking are Jung's primordial images, or archetypes, of which among a myriad he describes a number of those most commonly found: The anima (in men), and the animus (in women), the persona, the self, the mother archetype, the child archetype, the hero, the trickster. The unconscious of Freud, namely, the material suppressed from consciousness, he calls the shadow, and this lies at a more superficial level than his archetypes.

Since consciousness is an evolutionary phenomenon, just like any other biological organ, it proceeds by stages, and each individual recapitulates its development. Individuation is the process by which a working agreement is reached between archetypal (universal) unconscious processes and individual ego—the conscious processes. As Jung puts it: consciousness should defend its reason and protect itself, and the chaotic life of the unconscious should be given the chance of having its way too—as much of it as we can stand. This means open conflict and open collaboration at once. That, evidently, is the way human life should be. It is the old game of hammer and anvil: between them the patient iron is forged into an indestructible whole, an "individual."

For a quick and telling survey of the material of Part I, the reader is referred to the chapter, Conscious, Unconscious and Individuation. This is followed by A Study in The Process of Individuation, which is illustrated by a series of 24 mandalas in color, some arising spontaneously, some being the product of the technique of active imagination, and showing a patient's progress toward individuation. Here, as later in Part II, Jung exhibits an astonishing wealth of information concerning the history and content of alchemy, a subject he evidently discovered and delved into only in his late years. As in his erudition in regard to religions (East and West), we glimpse an area in which he shows an astounding scholarly familiarity and amazing psychological insight.

Without reference to its therapeutic value, this material constitutes most valuable readings in the history of our ancient psychological development and their residuals today, together with wise insights into the human's paradoxical behavior and with

pungent comments on aspects of the world religions and the ethical and political climate of today. It is recommended as essential background reading for psychiatrists, psychologists, sociologists, and cultural anthropologists.

Part II, *AION*, is new material, concerned with the archetype of the "self," (the whole person) and specifically in order to show the change in the psychic situation within the Christian aeon, with the aid of symbols from Gnosticism, Christianity, and Alchemy. Jung deals here with the dilemma of Christ and the Antichrist. Christ, as the symbol of wholeness, has a long history of antecedents. Especially does this hold true for the symbol Pisces of astrology. Consequently several chapters deal with the symbolism of the fishes in the gospels and in alchemy. The coming of the Antichrist was dated by the astrologists to the end of time, i.e., to the Second Coming, an expectation coinciding with the astrological conception of the "Platonic month" of the fishes.

The volume also discusses the Gnostic symbols of the self, and includes a chapter on the structure and dynamics of the self with special reference to the Quaternity as an organizing scheme of wholeness in alchemy. Jung concludes:

> Psychologically, the self is a union of conscious (masculine) and unconscious (feminine). It stands for the psychic totality.... Empirically ..., the self appears spontaneously in the shape of specific symbols, and its totality is discernible above all in the mandala and its countless variants. Historically these symbols are authenticated as God-images.... The anima/animus stage is correlated with polytheism, the self with monotheism. The natural archetypal symbolism, describing totality that includes light and dark, contradicts in some sort the Christian but not the Jewish or Yawistic viewpoint, or only to a relative degree. The latter seems to be closer to nature and therefore to be a better reflection of immediate experience. Nevertheless, the Christian heresiarchs tried to sail round the rocks of Manichaean dualism, which was such a danger to the Early Church, in a way that took cognizance of the natural symbols, and among the symbols for Christ, there are some very important ones which he has in common with the devil, though this had no influence on dogma.

This is an original and new work, scholarly, erudite, and with keen insight into the historic struggle to incorporate Christian doctrine into prevailing—one might say natural—modes of thinking and expression, as seen in Christian mysticism and alchemy.

WENDELL MUNCIE

PSYCHOLOGY AND RELIGION: WEST AND EAST. *Bollingen Series XX. The Collected Works of C. G. Jung. Vol. II.* *By C. G. Jung; translated by R. F. C. Hull. Pantheon Books, New York.* $6.00. xiv + 699 pp. 1958.

Part I of this volume contains the revised and augmented Terry Lectures given at Yale University in 1937 under the title *Psychology and Religion*, together with the original studies, A Psychological Approach to the Dogma of the Trinity, and Transformation Symbolism in the Mass, as well as the powerful Answer to Job and several shorter papers—all relating to Western psychology and religion.

Part II consists of a commentary on or discussion of the Tibetan Book of The Great Liberation, the Tibetan Book of the Dead, Yoga and the West, the Psychology of Eastern Meditation, The Holy Men of India, and a foreword to Suzuki's *Introduction to Zen Buddhism*—all obviously pertaining to Eastern religion and psychology. There is also an amusing and insightful foreword to the (Chinese) I Ching, a method of exploring the unconscious by oracle determined by chance.

Jung approaches his topic by way of a special definition of religion as "a careful and scrupulous observation of what Rudolf Otto aptly termed the *numinosum*," and repeatedly clarifies his stand as that of a psychologist taking no stand on the validity of the metaphysical questions, except to admire those who can believe. Relying on his studies of the archetypes of the collective unconscious and of alchemy, considered as the extension into medieval times of Christian mysticism (Gnosticism), and contrasting these findings with his studies of modern mandalas, he comes to some conclusions (or suggestions) which will be at least provocative, if not disturbing, to modern ecclesiastics, and especially to Protestants (Jung is himself a Protestant).

For example: The spontaneous mandalas and dreams suggest strongly the belief that God resides within man, and does not have an outside reference; that the spontaneous representation of God demands a Quaternity (rather than a Trinity); that the *missing* fourth element in Christian Doctrine represents Satan (i.e., Evil as offsetting good); that Woman (i.e., wisdom), and Evil (i.e., disobedience), and Earth (i.e., materiality) have a certain psychological equality; and that the Catholic Church in proclaiming the assumption of the Virgin Mary fulfilled a popular psychological need for the missing part of the Quaternity, with an intercessor for man in the material person of the Bride of Christ, and the feminine counterpart to God (Sophia).

The Modern Mandala contains no deity, therein constituting "an involuntary confession of a peculiar mental condition.... The place of the deity seems to be taken by the wholeness of man." It is "typical of people who cannot project the divine image any longer" and "are in danger of inflation and dissociation of the personality.... The round

or square enclosures about the center denote and assert exclusive concentration on the center, the self. This is anything but egocentricity. On the contrary, it is a much needed self-control for the purpose of avoiding inflation and dissociation."

With great insight Jung asserts: "One of the toughest roots of all evil is unconsciousness, and I could wish that the saying of Jesus, 'Man, if thou knowest what thou doest, thou art blessed, but if thou knowest not, thou art accursed, and a transgressor of the Law' were still in the gospels (from James: *The Apocryphal New Testament*).... It might well be the motto for a new morality."

In a short paper entitled Psychotherapists or the Clergy are to be found some of the most remarkable statements of the differing provinces and methods and goals of the two disciplines which I have ever seen; and this paper should be required reading not only for the clergy who hope to do "pastoral counselling," but for all young psychiatrists who are almost certain today to be immersed exclusively in Freudian theory.

Among these statements the most telling are the following paragraphs:

> We Protestants must sooner or later face this question: Are we to understand the 'imitation of Christ' in the sense that we should copy his life and, if I may use the expression, ape his stigmata; or in the deeper sense that we are to live our own proper lives as truly as he lived his in its individual uniqueness? It is no easy matter to live a life that is modelled on Christ's, but it is unspeakably harder to live one's own life as truly as Christ lived his.... Modern man has heard enough about guilt and sin. He is sorely enough beset by his own bad conscience, and wants rather to know how he is to reconcile himself with his own nature—how he is to love the enemy in his own heart and call the wolf his brother.

> The answer to Job proves to be a powerful exposition of the evolution in the Biblical conception of Yahweh under the impact of the determined loyalty of his creature, Job, and the answer comes finally in Jesus' despairing cry from the Cross in which "his human nature attains divinity; [and] at that moment God experiences what it means to be a mortal man and drinks to the dregs what he made his faithful servant Job suffer." Also: "The fact that the life of Christ is largely myth does absolutely nothing to disprove its factual truth—quite the contrary.... The mythical character of a life is just what expresses its universal human validity."

Concerning the East, Jung, while showing great respect for the inward-turning in meditation for the "answers" to life's problems, cautions against its use of Westerners who do not have the necessary cultural matrix for its proper development and understanding.

As in the other volumes, the writing in this one is powerful: a lucid plea for a return to an understanding of an application of the collective unconscious as a valuable, and even necessary, ingredient in the psychology of religion. The volumes are beautifully edited, without a single error in typography, and the paragraphs are numbered for ready reference.

Even if one cannot use (because of his own limitations) the material directly in treatment, acquaintance with Jung's thoughts is a richly rewarding experience in itself. I can only wonder at the prodigious activity and scholarly productivity of this great psychiatrist, who has left his stamp on current thinking.

WENDELL MUNCIE

CURIOSITY. *The Freud Anniversary Lecture Series. The New York Psychoanalytic Institute.*

By Herman Nunberg. International Universities Press, New York. $3.00. 88 pp. 1961.

MENTAL SUBNORMALITY. *Biological, Psychological, and Cultural Factors.*

By Richard L. Masland, Seymour B. Sarason, and Thomas Gladwin. Basic Books, New York; sponsored by The National Association for Retarded Children. $6.75. vi + 422 pp.; ill. 1958.

PSYCHOLOGICAL PROBLEMS IN MENTAL DEFICIENCY. *Third Edition.*

By Seymour B. Sarason; Part 2 by Seymour B. Sarason and Thomas Gladwin. Harper & Brothers, New York. $6.50. xvi + 678 pp.; ill. 1959.

The contents of these two books overlap. A monograph by Gladwin and Sarason entitled *Psychological and Cultural Problems in Mental Subnormality* appears in both. The first book contains in addition a monograph by Masland entitled *The Prevention of Mental Subnormality*. The second book contains in addition a new edition of Sarason's *Psychological Problems in Mental Deficiency*. The prospective purchaser should note that the Sarason-Gladwin monograph has previously appeared as a Genetic Psychology Monograph and in a special edition of the *American Journal of Mental Deficiency*, and that the Masland monograph also has previously appeared in periodical form.

Masland's monograph is a useful survey of the forms of mental deficiency which have some known or suspected organic component. It reviews epidemiological, clinical, and experimental studies and points out areas where research may prove fruitful. Masland's own interests and experience have led him to the belief that organic damage to the brain may be important in the etiology of mental deficiency of all grades. It might be pointed out here that this opinion, useful as a hypothesis for research, should not be regarded as an established fact, and in particular should not be allowed to

inhibit investigation of psychological factors in mental deficiency.

The monograph by Sarason and Gladwin is a sociological survey of the present status of the problem (if a psychologist and an anthropologist will permit me to call their joint effort sociological). It is a remarkable book because the unremitting honesty of the authors forbids them to conceal their dismay at the gaps in theory and practice which they found everywhere they looked. One can perhaps best comment on the book by giving the titles of the chapters, first remarking that every single chapter ends with a slightly startled summary of the degree to which our knowledge is either inadequate or palpably wrong and with a plea for more and better research! The chapters are as follows: Introduction to the Psychological and Cultural Factors; The Uneducated; Problem-Solving Behavior in Non-Test Situations; The Structure of Intellect; Heredity and Environment; Cultural Background Factors Affecting Test Performance; Intelligence and Culture; The Severely Defective Individual; The Higher Grades of Mental Defect; and Recommendations. One cannot, unfortunately, disagree with the authors' evaluation of the situation. Fortunately, however, there is one specialty which has maintained systematic special interest in the problem and that is the teaching profession. The authors are certainly correct in issuing a plea to all professions dealing with the human personality to direct their attention to the field of mental deficiency. They will find there not only problems of great practical importance but also problems the solution of which may have a very general theoretical interest. Sarason puts the matter well in the Preface to the second book: "The research anthropologist, or psychologist, or sociologist or psychiatrist needs the mentally subnormal individual in order better to understand the nature of man and culture."

Sarason's own book, *The Psychological Problems of Mental Deficiency*, is primarily a treatise for the psychologist with a professional interest in the diagnosis and handling of the mentally defective. It has become a standard work. One of the most important chapters is that on psychotherapy in which the author makes a convincing case for the efficacy and desirability of psychotherapy in mental deficiency.

A reading of these books leaves one with a curious mixture of confusion, despair, and optimism. The resurgence of interest in this vast, complex, neglected, and challenging field is a hopeful sign. The difficulty of the problem and the collapse of previous waves of interest in it are less hopeful signs. Perhaps, with luck, the current interest which these books represent and should enhance will lead to enough progress to break down the barriers of prejudice and therapeutic nihilism which have for so long kept the problem of mental deficiency isolated from the main stream of medical, psychological, and psychiatric research.

PAUL CRANEFIELD

HUMAN BIOLOGY

MANUAL OF PHYSICAL ANTHROPOLOGY. *Revised and Enlarged English Edition.*

By Juan Comas. Charles C Thomas, Springfield, Ill. $17.50. xxii + 775 pp.; ill. 1960.

When a field is rapidly changing, the textbook writer faces a three-pronged dilemma. If he looks ahead, his vision may prove faulty. If he looks to the past, his book may be born old. And if he tries to compromise, he can anticipate brickbats from both sides, being damned for whatever he does.

Physical anthropology today is just such a changing field, rapidly emerging from the typologies and descriptions and grosser anatomy of the past. It is a problem-oriented field, now far more laboratory-based, more statistical than descriptive, and (increasingly) more biophysical and biochemical than strictly anatomical. In completing his *Manual of Physical Anthropology*, Juan Comas has collided with this moving tide, and it is here that his troubles begin.

This is a large book, large even if the unnecessarily heavy stock and large type are discounted. It is a complete book, or rather a valiant try at a complete book, ranging from the history of physical anthropology to applications of physical anthropology. It includes the anthropometry, the indices, the typology, and the problems of the past, even to an extensive section on migration theory. It is thoroughly and lovingly documented, proving the author's command of the literature, and it is extensively, handsomely illustrated. But it is a hard book to review and recommend, despite such admirable features.

This manual—and it is a manual in the old-world sense—is filled with now-excess baggage. Few physical anthropologists west of the Danube currently practice Martin-style Congress of Monaco anthropometry. Few are concerned with biotypology. Few practice osteometry or spend long afternoons in museums measuring skulls. Few view human polymorphism in terms of endless migrations including trans-Antarctic Australoid treks. Few are particularly concerned with taxonomy for its own sake, and few follow the old Lincoln-Douglas era polyphyletic-monophyletic debates. Thus the *Manual of Physical Anthropology* is not an introduction to the subject, a book for beginners or for scholars who want to know what physical anthropologists do. Its major value is historical. It serves as a libretto for the older literature, and as a résumé of what

physical anthropologists once thought. In fact, there is no better book on the background of physical anthropology.

Today's physical anthropologists, however, are not represented in the *Manual*. They calcine bones instead of curating them; they stress them, radiograph them, decalcify them, or seek ancient antigens or subfossil collagen. They compare haptoglobins or globulins, hydrolyze hair, and simulate mating-isolates in computers. When they work with fossils, and many of them do, it is within the thought-frame of population genetics, and with the tools of experimental anatomy brought to bear.

The *Manual*, nonetheless, is a truly monumental work, the culmination of a century past, the accomplishment of a very learned and very wise man. It contains many sections of continued utility, and many words that merit a most solemn amen. It reminds us of the men who became martyrs for saying that mankind had a past, and (between the lines) the difficulties of getting over a humanistic approach in a more southern, less scientophilic land. It could be edited for today's student, though it is a problem as it stands.

Twenty years ago we went off to war and found a vastly different physical anthropology upon our return. Ten years ago we ventured unheard-of guesses about ongoing human evolution, and then found them dwarfed by actual discoveries. Such a rapid march of events is tough on textbook writers (and reviewers), but it explains why Juan Comas' erudition and knowledge are not entirely sufficient for the task. The present of physical anthropology belongs to the bright young men who program computers and spray chromatographs, although they lack the background Comas so amply displays. The problem is how to put the skills and knowledge together, how to write a textbook on physical anthropology that faces both ways, that carries the still-unsolved problems through to the techniques of the present, that salvages our accumulated data, and incorporates it into the thinking of today.

STANLEY M. GARN

DIE STRAHLENGEFÄHRDUNG DES MENSCHEN DURCH ATOMENERGIE. PROBLEME DER STRAHLENBIOLOGIE IM TECHNISCHEN ZEITALTER.

By Hans Marquardt and Gerhard Schubert. Rowohlt, Hamburg. DM 1.90 (paper). 184 pp.; ill. 1959.

One of the pleasures in browsing through a German bookstore is the ready availability of the Rowohlt paperbacks. These books cover wide fields of human knowledge and are written by experts for the intelligent layman. The present book continues this fine tradition. Both authors are respected and active investigators in radiation genetics, radiobiology, and nuclear medicine. In this book they undertake to inform the layman and scientist of the radiobiological problems facing mankind in the atomic age.

The book consists of 10 well-chosen chapters on topics such as the nature of ionizing radiation; the effects of irradiation on organisms down to the cellular level; the source of radiation exposures including those from natural background, medicine, and the increasing use of nuclear reactors; and on the theoretical and practical problems associated with permissible levels of radiation.

The authors present a well-balanced and sophisticated evaluation of potential radiation hazards arising from medical uses, both in therapy and diagnosis, and from natural background, radioactive wastes, and fallout. They properly and commendably emphasize the statistical judgments involved in the evaluation of possible long-term injuries arising from radiation exposures. An example of their critical judgment is in their presentation of the radiation doses delivered incidentally to gonads during routine X-ray diagnosis. They reproduce a table of gonad doses measured in a British hospital. Lest the reader think that these represent typical doses, they emphasize that the tabulated values are actually minimum values inasmuch as they were measured in one of the most modern hospitals with an experienced and alert staff.

The discussion of the radiation doses received from fallout is somewhat incomplete. It is not generally appreciated that the actual doses received are far greater than most laymen and scientists have been led to believe. For exmple, during the periods of active nuclear testing of H-bombs, the new-born child in the northern hemisphere received yearly radiation doses roughly *equal* to the natural background. For example, the emphasis on Sr-90 has obscured the fact that the total bone dose from strontium isotopes during this period was about ten times higher because of the contribution from the shorter-lived Sr-89. In addition, the external radiation from fallout on the ground contributed the equivalent of from two to five times the radiation received from Sr-90. When it is said that the total radiation dose from fallout is only one or two per cent of the natural background, it must be emphasized that this presumes no more above-ground testing for 70 years into the future. Since this proviso is not always explicitly stated, the very high doses received by the millions of children born between 1956 to 1958 have been overlooked. Sometimes I have wondered why the minimizers of fallout doses do not extend their estimates a thousand years into the future so that the average radiation dose to all the generations involved would be, within experimental error, essentially nil.

In a section on radioactive contamination from the testing of nuclear weapons the authors state that the responsibility for starting atomic war is

borne not by biologists and physicians but by politicians and militarists. I am sure that many readers will violently disagree with this point of view. Unfortunately, however, the peculiar apathy or passivity exhibited by the majority of scientists—and I do mean majority—toward the consequences of megaton warfare would indicate that such a view does prevail.

JACK SCHUBERT

BIOMETRY

THE ANALYSIS OF VARIANCE.

By Henry Scheffé. John Wiley & Sons, New York; Chapman & Hall, London. $14.00. xvi + 477 pp.; ill. 1959.

A review by a biologist and for biologists of a book on statistical theory may not do full justice to it, and this could be the case with Scheffé's book. It is a highly formal, comprehensive, and mathematical treatment of the theory of the analysis of variance. Throughout the 10 chapters packed with derivations of theorems and formulas, there is not a single numerical example in the text except for two small samples in connection with the permutation tests (p. 313). Nor does the book deal with the design of experiments, although some topics concerning design have been touched on incidentally. Contrary to the earnest hope of the author, the treatise cannot be considered suitable for self-study, at least not by users of statistical methods.

For those who are majoring in mathematical statistics, however, this book is something of a masterpiece. It contains practically all the important theorems in connection with the "A of V," a considerable number of which are due to the author himself. The general theory has been systematically laid out in the first two chapters. One-way classification (Chap. 3) is treated merely to illustrate some applications of the general theory. Chapters 4 and 5 deal with multiple classifications, Latin squares, and incomplete blocks. Chapter 6 is on the analysis of covariance. These 6 chapters constitute Part I of the book dealing with classical analysis of variance, i.e., with models with fixed-effects and equal variance for subgroups. Geometric interpretation has also been included.

The 4 chapters of Part II are on random-effects models, mixed models, randomization models, and the effects of departures from the usual underlying assumptions (normality, equality of variance, and independence of error). The author points out that the material in Part II has not yet attained a permanent form and will probably undergo considerable extension and revision upon further investigation.

C. C. LI

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

MEDICAL AND BIOLOGICAL RESEARCH IN ISRAEL.

Edited by Moshe Prywes. The Hebrew University of Jerusalem, Jerusalem; [Grune & Stratton, New York.] $8.00. xx + 562 pp.; ill. 1960.

This book can best be described as a travelogue carrying one through medicine, agriculture, and biology in Israel. It will be useful not only to those interested in that nation, but to anybody who wants to know how modern science can be applied efficiently to advance an under-developed country. Considering the adverse political and economic conditions which have beset Israel, it is amazing to see how much effort has been invested in research, and it should serve as an example to poor and underdeveloped nations that basic research is no luxury.

The book is divided into three parts. The first, accompanied by good photographs, describes the medical and scientific institutions in Israel. The second part deals with applied research in medicine and agriculture. The third part concerns Research of General Nature.

This subdivision into applied and non-applied research causes unnecessary repetition, since similar subjects, discussed in both sections, often come from the same laboratory, if not the same investigator (e.g., Population Genetics, p. 126, and Genetics, p. 274). There is an altogether excessive subdivision into subjects (56 chapters) which makes for choppy reading. Moreover, a lack of editorial firmness is evident in the lack of any unified style and approach. While some chapters are detailed and give a good picture of the activity in their respective fields (e.g., Chapters 26–32 on experimental biology, and Chapter 7 on mental health and social psychiatry), others are nothing more than an expanded reference list (e.g., Chapter 9 on population genetics, and Chapter 21 on the health protection of livestock). There is also a lack of clarity and consistency in the terminology used, Latin and common names being intermixed. The sections on ecology and taxonomy are written in a highly technical language which makes them unintelligible to a reader not well versed in these subjects.

Every chapter is supplied with a comprehensive reference list. It is a pity that many of these references, although decidedly of general interest, are available only in Hebrew, and thus remain inaccessible to those scientists in other countries who do not count an Israeli among their students or postdoctoral fellows.

The editor would have done well to include a good map of Israel with climatic and topographic details, instead of the 1½ pages of afterthoughts which are inserted in the back. Also, a subject index would have been of much greater value than the author index which is provided.

JOSEPH S. KAHN

THE QUARTERLY REVIEW OF BIOLOGY publishes critical reviews of recent researches in all of the special fields of biological science. The contribution should present a synthesis or digest of the researches and a critical evaluation of them. A mere synopsis of the literature without evaluation or synthesis is not desirable.

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In all matters of style the article should conform to the recommendations of the AIBS *Style Manual for Biological Journals*, prepared and adopted by the Conference of Biological Editors. Material ordinarily taking the form of footnotes is set in small print and placed in the text and consequently should be written in a style so as to fit readily into the text. Acknowledgments are printed in the text in small type at the end of the article just preceding the List of Literature. Recent issues of the Quarterly should be examined for style as regards (1) section or subsection headings in the text, (2) literature citations in the text, and (3) List of Literature. In the List of Literature each item should conform in the abbreviations to the usage of *Chemical Abstracts*, should supply the full title of the paper cited, and first and last page numbers as well as volume number of the journal.

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